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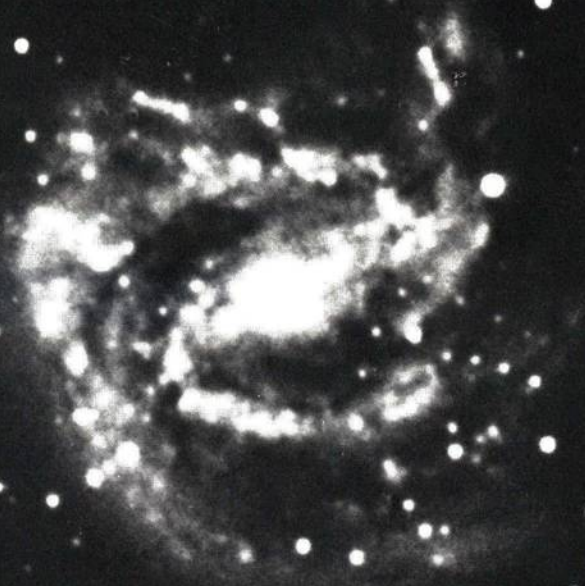

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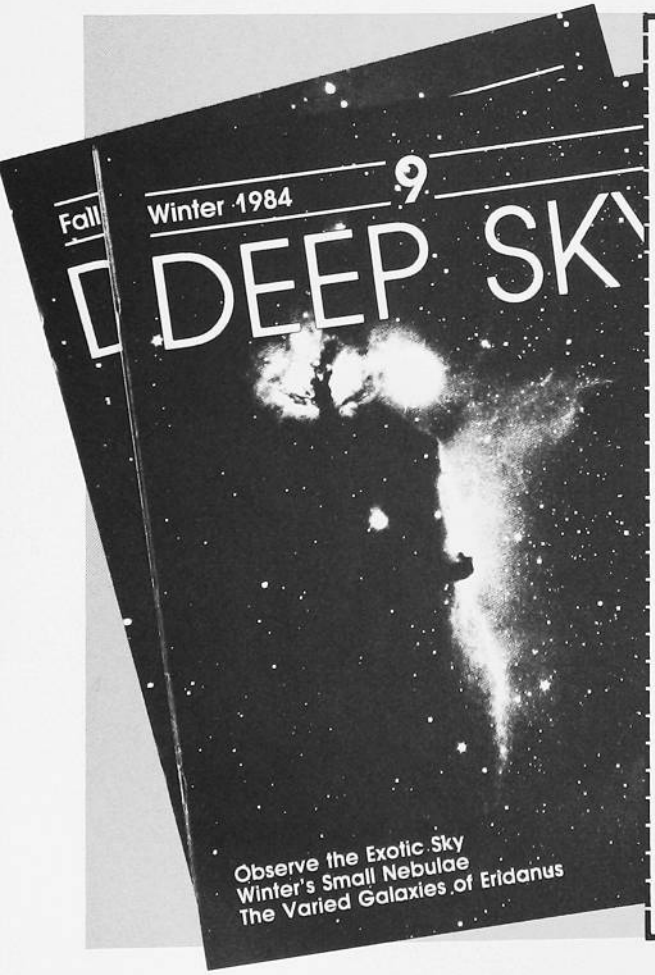

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DEEP SKY 14

The magazine for deep-sky observers and astrophotographers

Volume 4, Number 1
Spring 1986

Cover: Face-on barred spiral galaxy M83 in Hydra, photographed by Jim Riffle; 12-inch f/5 Astromak telescope, hypersensitized TP 2415, 60-minute exposure.

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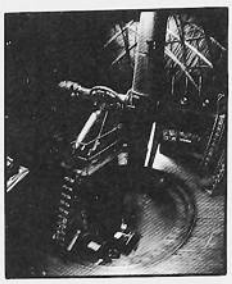

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6 On the Trail of Halley

by Phil Harrington

Undoubtedly many of Deep Sky*'s readers will follow Halley's Comet to the Southern Hemisphere this spring as the famous celestial visitor makes its last stand in April, swinging through the constellations Scorpius, Lupus, Centaurus, Hydra, and Crater. Expert observer Phil Harrington describes what deep-sky objects you can see along the way when you're not gazing at the comet. The table on page 10 lists complete data for 52 southern objects.*

14 Ten Days on Mars Hill

by David J. Eicher

Early in 1985 astronomers at Lowell Observatory invited Editor Dave Eicher to travel to Flagstaff, Arizona for two weeks of professional astronomy. In this article, Dave recounts his experiences — often exhilarating, sometimes fatiguing — as a temporary astronomer at one of the nation's oldest and most historic astronomical institutions.

22 Observing the IC 4329 Galaxy Group

by Jeffrey Corder

Southeast of the bright spiral M83 in Hydra lies a faint clump of galaxies known as the IC 4329 Group. Lying at a distance of some 45 megaparsecs, this small cluster of galaxies is relatively unknown although it contains 15 galaxies that are visible with backyard telescopes. In addition to full observational descriptions, sketches, and photographs, complete data appear for all galaxies in the cluster.

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Letters to DSM

Mapping the RNGC

Dear Dave / I very much enjoyed seeing Richard Berry's plot of the RNGC objects in *Deep Sky* 13, and am looking forward to seeing the plots of the NGH and SGH that are to follow. Many of the smallest dots, unfortunately, did not survive the printing process in my copy so I didn't get the full flavor of the distribution of nebulae along the Milky Way or of the faint galaxies away from it.

There does seem to be an intrinsic problem with the overall plot, though. There are no objects at all just south of the equator. I know that there are plenty of RNGC objects in this zone, so I'm wondering if perhaps the file you finally plotted had the −0 (minus zero) degree zone zapped somewhere along the line by the infamous inability of most computers to handle minus zeroes. This has given me headaches for years in our cataloguing work here at Texas (and also in Scotland when I was working there a few years ago — British computers are no more civilized than their American counterparts!). I've finally adopted the policy of reading the minus sign as a character rather than trying to read it as part of the declination.

Another possibility, of course, is that the computer saw the minus signs but the plotter didn't. Whatever the case, I hope that you can correct the problem of the empty belt before the next plot appears in *Deep Sky*.

One thing that you did not note in the write-up for this first plot was the pretty striking paucity of objects south of −30 degrees — the south was far from being as thoroughly explored as the north in the 19th century. Only John Herschel did anything like a systematic job of it (discounting poor James Dunlop's attempt).

Speaking of John Herschel brings me to my last point. The article states, "I wonder if the Herschels would have discovered the supergalaxy if they'd plotted all the objects in their GC." In fact, they did! One of the amazing feats of observational astronomy is William Herschel's first observing season (the winter of 1783/4) using his then-new 18.7-inch telescope. In that single season, he discovered from England (not exactly known for its pristine observing skies!) 500 nebulae — more than three times as many as had been found in all of history up to that time. Furthermore, he noted that many of the nebulae were located in a "great stratum" stretching across the northern sky more or less perpendicularly to the Milky Way. He, of course, did not know *what* he had found since he only had guesses about the true nature and distances of the "nebulae." Nevertheless, it is clear from reading his papers that he envisioned these nebulae as occupying a flattened belt around the sky just as most of the stars were located in the flattened belt of the Milky Way.

John Herschel also noticed the streams of nebulae across the sky (he specifically mentioned one leading north from the Large Magellanic Cloud that de Vaucouleurs dubbed the Southern Supercluster in 1953). So did almost every other astronomer who studied their distribution from then on. Given the "common knowledge" of the "streaminess" of the distribution of the galaxies, it may seem surprising that after their extragalactic nature was proved by Hubble in 1923/4, no one for thirty years suggested the obvious: that the galaxies were indeed arrayed in great flattened superclusters. This was Gerard de Vaucouleurs' great contribution in 1953.

I suspect that what kept others from the same realization earlier was Hubble himself. He had tremendous influence on the extragalactic astronomers of his day — after all, he had the largest telescopes in the world at his command, he had "discovered" the galaxies, and he had found their redshifts, too. Unfortunately, he had also stated that the galaxies were "uniformly and isotropically" distributed throughout space. Since belts, strata, and streams are obviously not manifestations of a "uniform and isotropic" distribution, they were simply ignored by most astronomers, who turned their attention toward other problems. Hubble had spoken. (To be fair, the distant galaxy data from the 60- and 100-inch telescopes on Mt. Wilson *are* much "smoother" than the data from the GC or the NGC. At first glance, they do indicate a pretty uniform distribution across the sky.) Only astronomers at Harvard (Shapley and Bok) and in Scandinavia (Lundmark, Holmberg, and Reiz) had anything to say to the contrary, and they were also ignored. But they, too, were closer to the "truth" as we believe it today.

Well, I hadn't intended to go on at such length, but I think that the whole story of the "discoveries" of the Local Supercluster (starting with Sir William) is most fascinating. There are several other equally fascinating tales involved that I've left out (Dunlop, Cleveland Abbe, and J.H. Reynolds, for example), but William Herschel's feat still completely astonishes me as one of the great unsung achievements of observational astronomy.

So keep up the good work. I'm looking forward to the next plot with keen anticipation.

Harold G. Corwin, Jr.
Astronomy Department
University of Texas at Austin
Austin, TX 78712

Dear Harold / Thank you for the commentary and background information on Herschel's Winter of Great Discovery. Regarding our RNGC plot, the gap just south of the equator was not a computer problem but a production one. The map contained so much data that we had to create it in strips and paste it together before a film was made for the printing plate. The gap resulted from piecing together the strips. Unfortunately, we left a small gap. (The upcoming maps, by the way, are single pieces which will not show this flaw). As for the tiniest dots, we did our best. Invariably, many of the smallest got lost or didn't print because they simply became too tiny at that scale. We hope readers liked the different perspective on the RNGC and we'll continue to attempt such articles in the future. — DJE

A Grand Night of Observing

Dear Dave / I've been an amateur astronomer for more years than I'm willing to admit, and my main interest is deep-sky observing. First, I wish to thank you for the best publication that caters to our tastes.

Since you are from western Ohio, I need not tell you about the problems with weather and light pollution in the area. I live in a small town (8,000+ population), just two blocks from the county courthouse. Not only do I suffer from the lights downtown, but my home is on a corner lot and there is a streetlight just a few yards away from the house. I lack a good dark observing site, so I do my best from the house. A few months ago I purchased a 10.1-inch Dobsonian, which travels with me and the family when we go camping. I thought I would never see many of the objects I spotted out in the country from my house, but there was a surprise in store.

A couple of weeks ago, a strong weather system swept through the area. The Moon was new and the sky was the darkest I'd ever seen from my home. I

set up the 10.1-inch scope and started observing. NGC 7009 was easy to find and high powers showed the planetary's bright disk well. It was obviously elongated and I suspected seeing the ansae — although later I doubted it. (Has anyone seen them with a 10-inch telescope?)

I started scanning around with no particular aim when I came across a huge bright glow. Sighting along the tube, I identified it as M33. While I've seen the galaxy from other locations, I never expected to see it from my house. NGC 604 was clearly visible, along with other knots in the arms. My low-power eyepiece provides a 1° field of view, allowing me to trace the arms out about 30′ to 35′. Thus encouraged, I tried other "difficult" objects — at least difficult from my location. M74 showed traces of arms. M76 was child's play. I was impressed. Then I tried NGC 404. While the low-power eyepiece didn't reveal this object, at slightly higher power it was easy, showing a triangle with Beta (β) Andromedae and a faint star. Its high surface brightness surprised me.

But my crowning achievement was none other than the Veil Nebula. Starting with 52 Cygni, I scanned the area. NGC 6960 was beyond me — the downtown lights masked it. I tried moving 52 Cyg out of the field, but no luck. I continued searching the area and found NGC 6992/5. The pale wreath of nebulosity looked like a braid weaving through the many faint stars sprinkled in the area. It was a gentle arc, elusive and delicate. It took me a while to break free from gazing at the Veil, but finally — at about 2:30 a.m. — I spotted Halley's Comet and, in the same area, M1, M35, and NGC 2158, which looked like a tiny comet sprinkled with glitter.

I realize that nights like this are like the famous comet — once in a lifetime (unless, of course, you live in Arizona). But it's a good message not to give up even if your observing site is less than ideal. If you can't see some of the fainter objects, consider every routine observing session practice for that special night when the sky is perfect, the Moon is new, and your neighbor turns off his front porch light.

Clear skies always.

Joanne Konst
127 East North Street
Kenton, OH 43326

Devoted Reader

Dear Mr. Eicher / With the possible exceptions of three-day weekends and five o'clock on weekdays, I eagerly await few things more than the quarterly arrival of *Deep Sky* magazine. I find my absorption in the magazine at five different stages: 1) eager cover-to-cover reading; 2) slow scrutiny of the photos and sketches; 3) in-depth study of the text a second time; 4) careful recording of notes for my own observations; and 5) slow, deep sighs of satisfaction of once again having read about the subject I love.

Although I take astronomy seriously, I find that at times I look for a lighter side. (This usually happens after finally having located that faint smudge of a galaxy just before unannounced thick clouds roll in.) I want to share one idea conceptualized at just such a moment. The problem, as I see it, is this: at times it seems difficult to find a bright object, when at other times it's seemingly easy to find a faint object. Thus I composed the Mahakian Gratification Formulae, for measuring the satisfaction one receives from viewing any given deep-sky object.

For galaxies, the formula is: Gg = H x M / S; where Gg is the gratification derived from viewing a galaxy, H is the number of hours needed to find and view the galaxy, M is the galaxy's visual magnitude, and S is the galaxy's longest dimension in arcminutes.

For nebulae, the formula is: Gn = H x M / D − 2f; where Gn is the gratification derived from viewing a nebula, H is the number of hours needed to find and view the nebula, M is the nebula's visual magnitude, D is the nebula's diameter in arcminutes, and f is the number of filters you used.

For globular clusters, the formula is: Ggc = N / D; where Ggc is the gratification derived from viewing a globular, N is the eastimated number of stars resolved, and D is the diameter in arcminutes.

These formulae may be unscientific, but they let me remember what I felt when viewing an object. I don't know, though. My wife says I'm crazy about astronomy. I'm beginning to think she's right!

Hank Mahakian
Box 105
Verplanck, NY 10596

Inside View

DSM Goes Newsstand

You'll notice this issue's newly designed cover that features the face-on Sc galaxy M83 in Hydra. With this issue, *Deep Sky* magazine will become available on selected newsstands around the United States through Eastern News Distributors of New York City. We're happy to be available "on the street" and will continue to bring the best possible coverage of deep-sky astronomy to our readers, whether they subscribe or pick up a copy at B. Dalton's.

This month's lead article by Phil Harrington describes deep-sky objects that you can observe along the path of Halley's Comet, which gave me the rare excuse to run a couple of Halley images in *Deep Sky*. As you'll see from reading Phil's article, there's plenty to observe in addition to the comet itself.

Also in this issue is a report on my visit last September to Lowell Observatory in Flagstaff, Arizona. Brian Skiff, who is Contributing Editor of this magazine and an astronomer at Lowell, invited me to participate in ten days of professional astronomy including photometry, astrometry, photography, visual observing, and occultation watching. My visit was an eye-opening opportunity to observe research astronomy in the 1980s. The story begins on page 14.

Several unusual items compose this issue's coverage of galaxies in the spring sky: David Levy's "Small Scope Showcase" on page 12, Jeff Corder's piece on observing the IC 4329 galaxy group in Centaurus, and Jay Albert's sketches of little-observed galaxies in Leo Minor. In "DSM Reports," Richard Berry presents the second part of his series on plotting the *Revised New General Catalogue*. This segment describes galaxies in the northern sky that are centered on the great Virgo cluster, and includes a map showing all galaxies in this area found in the RNGC.

I will be at the Texas Star Party in Fort Davis this year between May 5 and 10, and will be happy to discuss observing with any readers of DSM who may be present. If you're going, cross your fingers for clear skies!

Yours truly,

Dave Eicher
Editor

On the Trail of Halley

by Phil Harrington

Many deep-sky observers are migrating south this spring, not for warmer weather but for a chance to see the once-in-a-lifetime spectacle of Halley's Comet. For those who travel to lower latitudes, there are new and unfamiliar stars waiting for patient telescopes and binoculars. Along with these, Halley will pass many wonderous deep-sky objects as it swings through the southern sky. This article is a reference guide to some of those sights.

As spring begins, Halley will have just crossed into Sagittarius from Capricornus. Around March 15th, the comet's nucleus passes very close to the globular cluster **M75** (NGC 6864), a compact swarm of stars lying 18.4 kiloparsecs away. Small telescopes will not resolve the brightest stars in M75, which shine at 15th magnitude, but an 8-inch f/7 reflector will show it as a perfectly round, 5′ sphere glowing at magnitude 8.6.

Far more impressive is **M55** (NGC 6809). March 24th marks Halley's closest approach to this massive globe of stars, which Nicholas de Lacaille discovered while observing from the Cape of Good Hope in 1752. Partial resolution is possible in a 6-inch telescope, and a 12-inch scope offers a marvelous view. M55 measures 19.0′ in diameter; at a distance of 5.2 kiloparsecs, its physical diameter is 28 parsecs.

During the next few nights Halley will skim along the bottom of the Teapot, passing three Messier objects and several objects listed in the NGC. **M54** (NGC 6715) is located just southwest of Zeta (ζ) Sagittarii. While M54 shines at magnitude 7.7 and is considered a bright globular cluster, it is difficult to resolve due to its high concentration of stars. The view through an 8-inch scope at 300x will reveal a glimmering disk with a few individual stars resolved. A 10- or 12-inch scope is the smallest instrument to really do justice to this swarm of suns.

About 3° away is **M70** (NGC 6681). Although about a magnitude fainter than M54, M70 is easier to resolve. Telescopes of 3 or 4 inches' aperture will only show it as a glow, whereas larger instruments will reveal numerous member stars. Drop a degree farther south to find **IC 4776**. This is a challenging planetary nebula shining at photographic magnitude 11.7 and measuring 8″ across. I have failed to see it from Long Island in my 8-inch, but it might prove readily visible in the same instrument from a darker location. The largest backyard telescopes are necessary to spot its elusive 16th-magnitude central star. IC 4776 lies some 3.5 kiloparsecs away.

M69 (NGC 6637) is nearly a twin to neighboring M70. A 6-inch will display this 8th-magnitude globular as a hazy sphere with a few surrounding stars. Nearby is **NGC 6652**, a 9th-magnitude globular. My notes recall a 3′ diameter unresolved object showing slight central concentration. A 16-inch scope is probably the smallest instrument able to show NGC 6652's brightest member stars, which shine at 15th magnitude.

Southeast of the Teapot is **NGC 6723**, a bright, compact globular that is relatively unknown to most northern observers. I can resolve some of its 13th-magnitude members from New York, indicating that it must be a fine sight from southern latitudes. Overall, NGC 6723 shines at 7th magnitude and lies less than a degree away from a complex of faint nebulosity. **NGC 6726**, **NGC 6727**, **NGC 6729**, and **IC 4812**, the brightest areas of this nebulosity, have always appeared as low-contrast glows. Try observing them from a more favorable vantage point and let *Deep Sky* know of your findings.

These interstellar clouds are actually located in the small constellation **Corona Australis**, which Halley crosses into by April 1st. The brightest stars of the Southern Crown shine at only 4th magnitude thus are easily lost in horizon haze for northern observers. From southern latitudes, though, their semicircular shape is visible against magnificent star clouds of the summer Milky Way.

By following the Southern Crown's arc to Beta (β) Coronae Australis, you will be in the neighborhood of **IC 1297**. This planetary is a real test for most observers. Its 7″-diameter disk is so faint that it can be easily mistaken for a 12th-magnitude star, just another speck in a very rich area of sky. High power is required to distinguish IC 1297's nature. A helpful hint when searching for small, faint planetaries such as this is to move a nebula filter in and out of the telescope's optical path. The filter will cause the field stars to dim while the planetary remains unchanged or appears to brighten.

Far more impressive is the globular cluster **NGC 6541**. Halley will make its closest approach to this object about April 3rd. Were it not for its low declination, NGC 6541 undoubtedly would have been included in Messier's catalogue. It shines at magnitude 6.6 and measures 13.1′ across. Even from 40° north latitude, I can resolve some of NGC 6541's 13th-magnitude stars with an 8-inch telescope at moderate power; from the southern states, it must be a marvelous sight in large instruments.

After seeing NGC 6541, move 2° farther west and you'll find **NGC 6496**. Also a globular but much fainter than its neighbor, NGC 6496 shines at 9th magnitude. Large telescopes may show some faint individual stars in this group.

By the end of March, Halley moves out of Corona Australis and passes into Scorpius. North of the comet's path is

the grand open cluster **M7** (NGC 6475). The unaided eye can easily pick it out from the rich surrounding Milky Way, but the best view comes with binoculars or a short-focus telescope. Larger, longer focal length instruments don't help the view, since M7 covers some 80′ — nearly three Moon diameters. M7's total magnitude is 3.3 and its brightest star shines at magnitude 5.6. This brilliant cluster lies some 240 parsecs toward the Galaxy's center.

Few observers can claim to have seen our next globular cluster, **NGC 6453**. Although plotted on both the *Sky Atlas 2000.0* and the *Skalnate Pleso* atlas, the cluster remains relatively unknown. NGC 6453 glows dimly at magnitude 10 and measures a mere 3.3′ across. Just southeast of M7 is **Trumpler 30**, a faint galactic cluster. It contains 20 stars, none brighter than 9th magnitude.

Another seldom-observed globular is **NGC 6441**, which lies only 4.5′ from the 3rd-magnitude star G Scorpii. This cluster shines at 7th magnitude and covers an area 7.8′ in diameter. A 6-inch telescope will readily reveal a fuzzy, round patch of light, but resolution is impossible in backyard scopes. The brightest stars glow at 17th magnitude and are tightly packed together.

Close to the Scorpion's stinger is the open cluster **NGC 6400**. Here you'll find two dozen magnitude 9 to 10 stars, which merge to create a fairly rich appearance within an 8′ field. Nearby is **Harvard 16**, a gathering of 70 very faint stars scattered over 15′.

M6 (NGC 6405) is a sparkling open cluster situated to the north. Both naked-eye objects, M6 and M7 were known about before the invention of the telescope and were mentioned in the A.D. 140 edition of Ptolemy's *Almagest*. Even at low powers M6 is a fine sight, containing 80 stars of 6th magnitude and fainter over 15′ of sky. The cluster lies about 600 parsecs away and has a physical diameter of 6 parsecs.

M6 is surrounded by five clusters, the finest of which is **NGC 6451** with its rich collection of 80 stars. A 3-inch telescope shows only the brighter cluster suns against a milky nebulosity. A 6-inch scope, however, resolves the group. About two dozen suns belong to **NGC 6416**, another galactic cluster that covers 18′. Here again, a 6-inch telescope presents a nice view.

Next we come to **NGC 6425**, which claims 35 loosely gathered luminaries. When looking for scattered clusters like this, be sure to use your lowest-powered eyepiece because high magnifications will show only the cluster's center. Now try your luck with **NGC 6404**, located directly south of M6. Its brightest stars are only 13th magnitude and are easily lost in the starry field. Lastly, **NGC 6383** may be found surrounding the 5th-magnitude triple star **h4962** (magnitudes 5.5, 10.5, and 10.5; separations 5.5″ and 13.5″, respectively). A dozen stars are held within the cluster's confines and are easy to spot in small telescopes — even finderscopes. NGC 6383 lies directly in the plane of the Milky Way as seen from Earth, less than 5° from our Galaxy's center in Sagittarius.

April 4th marks Halley's closest passage to **Trumpler 29**, an open cluster near ι^1 and ι^2 Scorpii. My 8-inch reflector showed Tr 29 as a lone 8th-magnitude star immersed in 20 stars of magnitude 10 and fainter. This cluster's richness should make finding it simple. To the northwest is **NGC 6380**, a faint globular cluster some 3.9′ across. Observers using the *Skalnate Pleso* atlas will have to plot the cluster's position for themselves, but Wil Tirion's *Sky Atlas 2000.0* shows it. Glowing dimly at 12th magnitude, the cluster will prove challenging with a 6-inch scope — especially from northern latitudes. Only the largest backyard scopes have a chance at showing some of NGC 6380's 16th-magnitude constituent stars.

Continuing along our northwest route, we next encounter the difficult target **Ruprecht 123**. Although 50 stars belong to this open cluster, most shine dimly at 15th magnitude. Their light combines to form a faint 12th-magnitude blur. North of Ru 123 is the planetary nebula **NGC 6337**. Using a medium-power eyepiece, look for a faint wisp some 48″ across nestled in a starry field. Careful scrutiny will show a pale blue smoke ring resembling a poor man's Ring Nebula. If you have a large telescope, excellent eyesight, and great observing conditions, you might be able to glimpse NGC 6337's magnitude 14.4 central star. Still farther along the line is the cluster **NGC 6318**. It contains over five dozen stars that are tightly packed into a 4′ diameter.

About 2.5° north is **NGC 6302**, the Bug Nebula. No, it doesn't look like a Volkswagen but more like a squashed figure 8. Backyard telescopes will show only the bright central portion as a green, irregular ellipse extending north and south. But photographs show that NGC 6302 is surrounded by faint nebulosity with many bright rays and curves extending radially outward.

On April 5th, Halley will move between **NGC 6322** and **NGC 6388**. The former is a bright, loose open cluster consisting of 30 stars that are scattered over 10′, making lower powers the best for viewing. NGC 6388 is a 7th-magnitude globular cluster, a featureless blob about 9′ across. Forget about resolving this one — its stars glow at magnitude 17 and fainter. **IC 4663**, a 13th-magnitude planetary measuring 18″ in diameter, can be found about 2° southeast of NGC 6388. High power and good seeing are needed to distinguish it from the surrounding field stars.

Perhaps the most beautiful open cluster in Scorpius is **NGC 6231**, which is positioned some 0.5° north of Zeta (ζ) Scorpii. Sharp-eyed observers may be able to catch a glimpse of this cluster without optical aid since it shines at magnitude 2.6. Binoculars show about 20 stars in NGC 6231, while 6- to 8-inch telescopes increase this number to several dozen. Most members of this stellar family are hot O and B stars, and the group lies 1.8 kiloparsecs away. If we could magically decrease this distance to 125 parsecs — the distance to the Pleiades cluster — the most luminous stars in NGC 6231 would rival Sirius in brightness!

NGC 6231 lies in the midst of a magnificent starry field, an area made for sweeping with a wide-field eyepiece. Two degrees northeast lies **Trumpler 24**. Short focal length telescopes produce the best views, as Tr 24's stars are spread over 80′. Over 200 stars populate the region, although not all of them are cluster members. A nebula filter may aid in detecting **IC 4628**, a faint cloud of nebulosity just northwest of Tr 24. Farther north is **NGC 6242**, another bright, rich galactic cluster. An 8-power finderscope displays it as a milky smudge, while a 3-inch telescope shows its magnitude 7 and fainter stars.

Nearby is **NGC 6268**, an inconspicuous cluster of 30 stars some 9′ across. Its 10th-magnitude and fainter stars are easily lost in the myriad of field stars. Were this cluster set against a sparser region of the sky, it would be far easier to capture. Southwest of Tr 24 is **NGC 6227**. Originally catalogued as an open cluster, astronomers now believe it is simply a rich field of stars. Finally we come to NGC 6281, which is just over 2° east of Mu (μ) Scorpii. Its 25 members are sprinkled in a triangular configuration, offering a pretty, rich display.

This entire region exemplifies the overwhelming magnificence of the Milky Way. The typical field of view contains stars of all colors and contrasts. Many of us are so accustomed to hunting down individual objects that we tend to forget the rich beauty of the sky. But not here; here nearly all of us will stop to catch our breath and perhaps remember what made us become amateur astronomers in the first place — the subtle, magnificent beauty of the sky.

Back on the trail of Halley, we come to the galactic cluster **NGC 6192**. A 12-inch scope shows about 75 stars of magnitudes 11 to 14 and anything smaller than a 10-inch telescope will show the cluster immersed in a nebulous glow.

The tail of the comet will sweep over our next two objects around April 6th.

The first is **NGC 6222**, a faint collection of about two dozen stars richly gathered in a 3′ area. Once you've observed NGC 6222, the next object will come with time — 10 minutes to be exact. Take a 10-minute walk; when you return, Earth will have turned your instrument to **NGC 6259**. This is a more impressive open cluster, containing 100 stars. The group is resolvable in a 4-inch telescope and might be spotted in finderscopes by observers with sharp eyes.

Riding the Scorpius-Ara border is **NGC 6178**. Only a dozen stars populate it, but most observers find it easily. Not a rich group, NGC 6178 will still make a nice addition to your list of observed open clusters.

NGC 6153 is a difficult planetary, shimmering faintly at magnitude 11.5 and measuring 25″ across. This combination helps to make its detection possible in a 6-inch scope, but larger telescopes show it as a small, grayish disk. Southeast of NGC 6153 is the open cluster **NGC 6124**. About 100 stars are collected within 29′, giving a total magnitude of 6. The last object in Scorpius is the small globular cluster **NGC 6139**, which is inconspicuous at 9th magnitude and appears unimpressive in small telescopes. The 16th-magnitude stars that form this cluster can be resolved only in the largest backyard telescopes.

On April 6th, witness Comet Halley crossing into the southern constellation **Ara** for a visit that will last only 24 hours. Ara, the Altar, offers little to the naked eye; its brightest stars shine at only 3rd magnitude, yet it is a splendid area for telescopic surveying.

First, look toward the region of **NGC 6188** and **NGC 6193**. The former is a fascinating combination of bright and dark nebulosity; its resemblance to Orion's Horsehead Nebula is unmistakable. This cloud is only the tip of a celestial iceberg: studies indicate NGC 6188 is at the center of nebulosity that extends over 3°. NGC 6193 lies at the northeast extreme of this cloud. It is a rich congregation of 30 stars set against an even richer field — the brightest is **h4876**, a quadruple star. Its primary shines at 6th magnitude and about 10″ away at p.a. 266° lies a 7th-magnitude companion. A third, 10th-magnitude star can be seen at p.a. 14°, but it is only 1.6″ distant. The fourth member is an 11th-magnitude star at p.a. 160° and about 13.5″ away.

The comet is seemingly set on a collision course with the open cluster **NGC 6204**. The brightest of NGC 6204's 25 stars shine at 11th magnitude and the cluster's overall integrated magnitude is 9. You may find **NGC 6250** a little easier. Set just inside Ara's northern border, it is a weak harvest of 15 stars, the brightest shining at 8th magnitude.

For globular cluster fans, Ara is the home of one of the best such objects. **NGC 6397** shines at magnitude 5.7 and is easily resolvable into individual stars with a 6-inch telescope. The cluster lies only 2.2 kiloparsecs away and would undoubtedly be one of the most frequently observed globulars if it were more visible from northern skies.

NGC 6352, about 5° to the north, makes for an interesting comparison. Depending on your latitude, NGC 6352 might be a more rewarding sight even though it is smaller and fainter than NGC 6397. NGC 6352 shines at 8th magnitude and appears somewhat mottled in smaller scopes. An 8-incher may resolve this cluster, though its 14th-magnitude cluster stars make a 10-inch or 12-inch telescope more practical.

South of NGC 6352 and west of Alpha (α) Arae is the cluster **IC 4651**. You should find it a fairly easy catch. IC 4651's 80 stars are concentrated across 12′ and have a combined brightness of magnitude 6.9. **NGC 6253** contains an equal number of faint stars yet they appear strikingly different, far more concentrated than those of IC 4651 and with a combined diameter of only 5′ across.

Planetary nebulae always prove challenging, even to veteran observers. **NGC 6326** will provide a good test for your observing skills. It shines at 12th magnitude and appears slightly oval. Begin your search for its dim, grayish 14″ disk by aiming at a point about 2° southwest of α Arae; use a medium power eyepiece since the nebula is difficult to spot with low power.

Before Halley leaves the vicinity, look at **NGC 6208**, a large, rich open cluster. A 6-inch telescope is capable of resolving most of its 60 stars provided the cluster is reasonably high above the horizon. If conditions permit, switch to a higher-power ocular; this cluster bears magnification well.

As we follow the trail of Halley westward, our attention turns to **Norma**, the Square. The comet crosses into this constellation on April 7th. This is a poor region for the unaided eye, highlighted only by 4th- and 5th-magnitude stars. Halley quickly traverses the northern portion of the constellation, but our focus will be aimed toward the deep-sky objects to the south.

The nebular complex **NGC 6164/ NGC 6165** is just south of Halley on April 7th. This is an extremely faint nebula that surrounds a hot BO-type star. The star's brightness may overpower the nebula's tenuous wisps, making averted vision necessary. If a nebula filter is available, give it a try; it might improve the nebula's contrast sufficiently to help your view of this elusive target.

Nudge your telescope about a degree to the southwest to find **NGC 6134**, a large, rich gathering of 60 stars that are 11th magnitude and fainter. This cluster has an overall magnitude of 7.3 so it should be visible in telescopes as small as 3 inches in diameter. Another pretty cluster about 3.5° farther south is **NGC 6152**. It consists of 70 stars, but they are not as tightly packed together as those in NGC 6134. Here a 3-incher should show several 9th-magnitude stars and since NGC 6152 has a diameter equal to that of the Full Moon, use your widest-angle eyepiece for the best views.

Moving even farther south, we meet up with **NGC 6067**, the finest open cluster in Norma. Over 100 stars dot this region to form a very bright, rich field. If you find yourself at a latitude that permits viewing this object, do not pass up the bright open cluster NGC 6067 located at −54° declination. It will be about 8° south of Halley's Comet on April 8th. West of NGC 6067 is the disappointing cluster **NGC 6031**. This is certainly not a spectacular object, but it is distinguishable. If you have trouble finding it, try switching to moderate magnifications.

Can you spot the elusive planetary **Vorontsov-Velyaminov 78**? It is plotted on both Tirion's *Sky Atlas 2000.0* and the *Skalnate Pleso* atlas although it is unlabeled on the latter. To find VV 78, search for a small, very faint, grayish-colored disk. You will probably find **Shapley 1**, a 9th-magnitude planetary, a little easier to locate. Look for a 72″ diameter smoke-ring surrounding a magnitude 13.5 central star. An 8-inch telescope should show both although averted vision might be needed to bring out the faint nebulosity.

NGC 6087 is another fine galactic cluster located about 4° away from VV 78. It is a bright splash of 40 stars and can be seen in 7x binoculars. The brightest member is **S Normae**, a Cepheid variable. It fluctuates from magnitude 6.1 to 6.8 over a 9.75-day period.

Tracking westward past Iota (ι) Normae, we encounter the cluster **NGC 6005**. Here telescopes display a small, group of 35 stars compressed in a 3′ diameter. A 6-inch scope may be the smallest instrument capable of revealing this one as the group's integrated magnitude shines a dim 12. **NGC 5999** is two magnitudes brighter, yet it still presents a challenge for seasoned observers. To find this cluster, scan for a 9th-magnitude glow using low power. Once found, increase to medium or even high magnification and watch the glow disintegrate into a tight swarm of stars. Altogether, 40 stars populate NGC 5999, none of which are brighter than 12th magnitude.

We end our tour of Norma with two globulars. **NGC 5946** shines at 10th

magnitude and appears as nothing more than a faint smudge of light in most backyard instruments. This should come as no surprise, since its brightest stars glow weakly at 16th magnitude. **NGC 5927** is an 8th-magnitude globular just to the west. In fact, with a low-power, wide-angle eyepiece, both clusters just might fit into the same field of view. NGC 5927 appears twice the size of NGC 5946; you might be able to resolve it in large backyard instruments since the brightest stars shine at 15th magnitude.

Comet Halley crosses into **Lupus** the Wolf on April 9th and then begins to push northward. Because it will lie higher in the sky, the comet's visibility will improve for observers in North America and Europe. At the same time the comet will be fading, however. If you've been following the comet, you will have noticed that Halley is now leaving the plane of our Galaxy.

Halley passes just north of **NGC 5882**, a fairly bright planetary, on the evening of April 10th. Shining at photographic magnitude 10.5, NGC 5882 appears as a 7″-diameter disk in a 6-inch telescope. To find it, train your telescope between ε and λ Lupi. Both of these are double stars and present a fine challenge to large-telescope users. Epsilon consists of a 4th-magnitude primary and a 6th-magnitude secondary separated by 0.6″ at p.a. 247°. A 9th-magnitude star that is easily visible is located 26.5″ away at p.a. 171°. Lambda has a 5th-magnitude primary and a magnitude 5.5 companion at p.a. 178°. Superb conditions are needed to spot the companion since the stars are separated by only 0.2″.

Stretching along the southern border of Lupus are three open clusters worth observing. Moving from east to west, **NGC 5822** is first in line. This also happens to be the finest cluster in Lupus, with 150 stars settled into a 40′ diameter area. Drop a degree south to place **NGC 5823** in view. This object is a rich collection of 80 stars that are 13th magnitude and fainter.

Now return to NGC 5822 and continue westward. **NGC 5749** will soon come into view. About 20 stars dimmer than 10th magnitude belong to this group; the cluster extends 10′ across and bears magnification well. Finally we come to **NGC 5593**. Your search for this group will be rewarded with a view of 10 faint stars scattered over an 8′ field.

Lupus contains four additional deep-sky objects worth observing. All are clustered together along the border that Lupus shares with Centaurus. **IC 4406** is a large, faint planetary nebula. Although its light equals an 11th-magnitude star, its disk is 28″ across. This combination causes IC 4406 to have a low surface brightness. It is difficult to distinguish from the surrounding sky due to low contrast. A nebula filter may increase the IC 4406's contrast just enough to enable you to spot it.

The other three objects are the first of many galaxies that Halley will skim by in the next few months. Of these, **NGC 5643** is the brightest, its faint glimmer at magnitude 11.0. Classified as a barred spiral, this object will appear perfectly round. **IC 4444** is an Sb/Sc spiral of magnitude 12.5 and measures only 1.9′ x 1.7′ across. **NGC 5533** is about equal to this in brightness and is 3.2′ x 2.1′ across. An 8-inch telescope will show all three quite easily if used under a dark sky.

Now turn your attention toward **Centaurus**, one of two celestial centaurs (Sagittarius is the other). Along its journey through Centaurus, Halley's Comet will pass near NGC 5128, one of the most spectacular galaxies in the entire sky.

But first, on April 13th, the comet will lie south of **NGC 5483** and **NGC 5365**, both faint spiral galaxies. NGC 5483 shines at blue magnitude 12.0 and is visible as a small, round glow. NGC 5365 is only a 12.5-magnitude object in blue light; it also appears as a round glow but is only about half the size of NGC 5483.

That same evening, the open cluster **NGC 5460** will be about 3° south of Halley's nucleus. A keen-eyed observer might be able to spot this collection of two dozen stars without any optical aid on an extremely transparent night. A telescope shows all the cluster's members packed into a 25′ diameter. The brightest member is an 8th-magnitude star, making NGC 5460 visible in finderscopes.

About 8° south of Halley on April 14th is **NGC 5286**, a magnitude 7.6 globular cluster. Unless viewed through a 10-inch or larger scope, all you will see is a fuzzy disk of light some 9.1′ across. An 8-inch telescope may give the impression of a mottled surface, but a larger instrument is needed to resolve the 14th-magnitude member stars. Slightly to the northeast is **NGC 5307**. This faint planetary shines at only 12th magnitude and measures 15″ x 10″ across. You will have to search carefully to find it.

Our next target is the finest globular cluster in the entire sky — the one and only **Omega** (ω) **Centauri** (NGC 5139). The comet's head will be just north of Omega on April 15th. Both objects should be close in visual brightness, providing an unusual "double comet" effect. Omega shines at magnitude 3.7, making it easily visible with the naked eye. For ages this object was thought to be a star: Ptolemy included it as such in his catalogue of A.D. 140, as did Bayer in his listing made in the early 1600's (the latter is responsible for assigning it the Greek letter omega).

Because of its far southern declination, Omega is not visible from much of the United States. I have only spotted it once, in North Carolina during the May 30th, 1984 solar eclipse. Even though it never rose far above the glow from nearby Charlotte, Omega was still a glorious sight. The cluster appeared resolved with low power in my 8-inch so from the Southern Hemisphere the view is certainly breathtaking.

Astronomers estimate that Omega Centauri is 5.2 kiloparsecs distant, making it one of the closest globulars. Visually it is 36.3′ in diameter but deep photographs extend this to over 90′ across, corresponding to a physical diameter of 125 parsecs. The cluster probably contains over one million stars. The astronomer John Herschel summed up Omega nicely when he said: "*The noble cluster Omega Centauri is beyond all comparison the richest and largest object of its kind in the heavens. The stars are literally innumerable, and their total light affects the eye hardly more than a star of 4th magnitude; the minuteness of each star may be imagined . . . .*"

Surrounding Omega to the south are three faint galaxies — **NGC 5046, NGC 5156,** and **NGC 5266**. All are 13th-magnitude objects and appear as small, featureless smudges of light.

NGC 4945 is far more impressive in backyard telescopes. It is detectable as a fairly bright, cigar-shaped cloud of nebulosity with no notable central condensation. Photographs made using large telescopes indicate that it is an Sc spiral galaxy, which we are looking at nearly edge-on. While in the area, give **NGC 4976** a try. This is a 12th-magnitude E4 elliptical galaxy, about one-fourth as large as NGC 4945. A wide-angle eyepiece should just about squeeze both objects into the same field of view.

South of the comet on April 15th is **NGC 5128**, a highly unusual galaxy. Its 18.2′ x 14.5′ diameter glow is dramatically bisected by a wide obscuring dark lane. Astronomers have determined that NGC 5128 is a type S0 peculiar galaxy, but its dark absorption band remains mysterious. When we view NGC 5128, we are looking across 4.3 megaparsecs of space; the galaxy's true diameter is about 55 kiloparsecs and the peculiar dark lane has an average width of 1.8 kiloparsecs.

Many early 20th century astronomers suggested that NGC 5128 was not one galaxy but two in collision, which presumably explained the high level of radio emission. Further studies showed two lobes of radiation positioned opposite each other emanating from the galaxy's center. A strong magnetic field is implied, which might be generated from tremendous internal upheaval. NGC 5128 seems to be a prominent

Objects Along Halley's Path

Object	Type	R.A.(2000.0)Dec.	Con.	Mag.	Mag.*	N*	Size/Sep./Per.	P.A.	Distance
IC 764	S	12h10.2m −29°44′	Hya	12.2_B	—	—	4.8′ x 1.8′	—	25 Mpc
NGC 4219	Sb^+	12h16.4m −43°20′	Cen	12.09_B	—	—	4.5′ x 1.7′	—	25 Mpc
IC 3370	E2	12h27.6m −39°20′	Cen	11.07	—	—	2.8′ x 2.4′	—	35 Mpc
M68 (NGC 4590)	●	12h39.5m −26°45′	Hya	8.2	—	—	12.0′	—	9.6 kpc
NGC 4645	E3	12h44.2m −41°45′	Cen	12.78_B	—	—	2.2′ x 1.5′	—	30 Mpc
NGC 4945	SBc:	13h05.4m −49°28′	Cen	9.47_B	—	—	20.0′ x 4.4′	—	4.74 Mpc
NGC 5090	E2	13h21.1m −43°44′	Cen	12.64_B	—	—	2.6′ x 2.5′	—	40 Mpc
NGC 5102	S0	13h22.0m −36°38′	Cen	9.65	—	—	9.3′ x 3.5′	—	3.29 Mpc
NGC 5128	S0 pec	13h25.5m −43°01′	Cen	6.98	—	—	18.2′ x 14.5′	—	4.30 Mpc
NGC 5139	●	13h26.8m −47°29′	Cen	3.65	—	—	36.3′	—	5.2 kpc
NGC 5253	E5	13h39.9m −31°39′	Cen	10.55	—	—	4.0′ x 1.7′	—	2.78 Mpc
M83 (NGC 5236)	Sc	13h41.1m +67°40′	Dra	14.13	—	—	1.3′ x 1.2′	—	40 Mpc
NGC 5286	●	13h46.4m −51°22′	Cen	7.62	—	—	9.1′	—	8.9 kpc
NGC 5307	■	13h51.1m −51°12′	Cen	12.1p	—	—	13″	—	—
NGC 5460	⊙	14h07.6m −48°19′	Cen	5.6	8.01	40	25′	—	500 pc
IC 4406	■	14h22.4m −44°09′	Lup	10.6p	14.7_B	—	28″	—	1.5 kpc
IC 4444	$SB(b)^+$:	14h31.7m −43°25′	Lup	12.29_B	—	—	1.9′ x 1.7′	—	25 Mpc
NGC 5822	○	15h05.2m −54°21′	Lup	6.5p	10p	150	40′	—	550 pc
NGC 5882	■	15h16.8m −45°39′	Lup	10.5p	12.0_B	—	7″	—	1.9 kpc
Shapley 1	■	15h51.7m −51°31′	Nor	13.6p	13.87	—	76″	—	1.1 kpc
NGC 6067	○	16h13.2m −54°13′	Nor	5.6	8.25	100	13′	—	2.1 kpc
Vorontsov–Velyaminov 78	■	16h17.2m −51°59′	Nor	—	14.14	—	24″	—	2.1 kpc
S Normae	CV	16h18.9m −57°54′	Nor	6.12–6.77	—	—	—	—	—
NGC 6124	○	16h25.6m −40°40′	Sco	5.8:	8.67	100	29′	—	490 pc
NGC 6153	■	16h31.5m −40°15′	Sco	11.5p	—	—	25″	—	—
NGC 6192	○	16h40.3m −43°22′	Sco	8.5p	11p	60	8′	—	—
NGC 6231	○	16h54.0m −41°48′	Sco	2.6	4.71	—	15′	—	1.8 kpc
NGC 6242	○	16h55.6m −39°30′	Sco	6.4	7.28	—	9′	—	1.2 kpc
NGC 6259	○	17h00.7m −44°40′	Sco	8.0	11.64	120	10′	—	770 pc
NGC 6302	□E	17h13.7m −37°06′	Sco	12.8p	—	—	50′	—	0.6 kpc
NGC 6337	■	17h22.3m −38°29′	Sco	—	14.75	—	48″	—	1.2 kpc
Ruprecht 123	○	17h23.4m −37°56′	Sco	—	10p	50	9′	—	—
Harvard 16	○	17h31.4m −36°51′	Sco	—	—	70	15′	—	—
h4962	$★^2$	17h34.7m −32°35′	Sco	5.7, 10.5	—	—	5.4″	102°	—
NGC 6380	○	17h35.4m −39°04′	Sco	—	—	—	3.9′	—	8.7 kpc
M6 (NGC 6405)	○	17h40.1m −32°13′	Sco	4.2	6.17	80	15′	—	600 pc
NGC 6397	●	17h40.7m −53°40′	Ara	5.65	—	—	25.7′	—	2.2 kpc
NGC 6400	⊙	17h40.8m −36°57′	Sco	8.8p	9p	60	8′	—	—
Trumpler 29	⊙	17h41.6m −40°06′	Sco	7.5p	—	30	9′	—	—
NGC 6416	⊙	17h44.4m −32°21′	Sco	5.7	8.43	40	18′	—	800 pc
NGC 6425	⊙	17h46.9m −31°32′	Sco	7.2	10.15	35	8′	—	800 pc
NGC 6441	●	17h50.2m −37°03′	Sco	7.42	—	—	7.8′	—	10.3 kpc
NGC 6451	⊙	17h50.7m −30°13′	Sco	8.2p	12p	80	8′	—	570 pc
M7 (NGC 6475)	⊙	17h53.9m −34°49′	Sco	3.3	5.60	80	80′	—	240 pc
Trumpler 30	⊙	17h56.5m −35°19′	Sco	8.8p	—	20	10′	—	—
NGC 6541	●	18h08.0m −43°42′	CrA	6.64	—	—	13.1′	—	6.9 kpc
M69 (NGC 6637)	●	18h31.4m −32°21′	Sgr	7.70	—	—	7.1′	—	10.3 kpc
M70 (NGC 6681)	●	18h43.2m −32°18′	Sgr	8.08	—	—	7.8′	—	10.8 kpc
IC 4776	■	18h45.8m −33°21′	Sgr	11.7p	14.6	—	8′	—	3.5 kpc
M54 (NGC 6715)	●	18h55.1m −30°29′	Sgr	7.70	—	—	9.1′	—	21.5 kpc
IC 1297	■	19h17.4m −39°37′	CrA	—	12.91v	—	7″	—	5.1 kpc
M55 (NGC 6809)	●	19h40.0m −30°58′	Sgr	6.95	—	—	19.0′	—	5.2 kpc
M75 (NGC 6864)	●	20h06.1m −21°55′	Sgr	8.55	—	—	6.0′	—	18.2 kpc

Column 1: designation in *Revised New General Catalogue* by J. Sulentic and W. Tifft, *Index Catalogue* by J.L.E. Dreyer, *Yale Catalogue of Bright Stars* by D. Hoffleit, and additional lists. **Column 2:** object type: $★^2$ = double star; CV = Cepheid variable; ○ = open cluster; ● = globular cluster; ■ = planetary nebula; □E = emission nebula; Hubble types given for galaxies. **Column 3:** coordinates for epoch 2000.0. **Column 4:** constellation in which object lies. **Column 5:** V magnitude unless otherwise noted; subscript B denotes blue magnitude, subscript p denotes photographic magnitude. **Column 6:** magnitude of central star for planetary nebulae or brightest cluster member for open clusters. **Column 7:** number of stars in open clusters. **Column 8:** separation in arcseconds for double stars, period in days for variable stars, or angular size in arcminutes or arcseconds for other objects. **Column 9:** position angle for double stars. **Column 10:** distance in parsecs, kiloparsecs, or megaparsecs. Compiled by D. Kendzie-Holdaway.

black hole candidate.

An 8x finderscope will show NGC 5128 as a fuzzy star of 7th magnitude and the dark lane will show up in a 6-inch scope at medium power. This galaxy is a one-of-a-kind sight and should not be overlooked by observers who are far enough south for a good view.

Nearby are two more challenges: **NGC 5011** and **NGC 5090**, both 13th-magnitude elliptical galaxies that are nearly identical in appearance. They each measure only about 2′ in diameter and could easily be missed in a quick sweep of the area at low power.

To the north of Halley's trail are a number of other faint galaxies. These include NGC 4947, NGC 5102, NGC 5121, NGC 5161, NGC 5181, NGC 5193, NGC 5253, and IC 4296. **NGC 5102** is the easiest to find since it's only 17′ east of the bright star Iota (ι) Centauri. Without clean optics and a haze-free sky, Iota's light may be scattered sufficiently to choke out this 10th-magnitude galaxy. If that is the case, move Iota just out of view so that its light doesn't dazzle your eyes.

What is **NGC 5253**? Some catalogues call it an unusual elliptical galaxy while others classify it as an irregular. The confusion stems from photographs that show the nucleus containing great clouds of nebulosity, which are certainly not characteristic of elliptical galaxies. However, longer exposures make NGC 5253 look like a normal E4 system. Overall, NGC 5253 measures 4′ x 1.5′ in diameter. In both 1895 and 1972 a supernova in NGC 5253 flared to magnitude 7.2 — over 30 times brighter than the galaxy itself, which is thought to include some 13 billion suns. The other galaxies in this vicinity all shine between

magnitudes 12 and 13.5 and are visible in 8-inch and larger telescopes.

Less than 2° north of NGC 5253, just over the Hydra border, is the magnificent spiral **M83** (NGC 5283). M83 is one of the finest galaxies in the southern sky. Discovered by Lacaille in 1752, today's telescopes display it as a massive stellar system with two main spiral arms and a third, fainter one. This structure leads it to be classified as a "three-branch" spiral.

South of Halley on April 17th and 18th is a collection of nine dim galactic targets. All are plotted and numbered on the *Sky Atlas 2000.0*, while eight are shown unnumbered on the *Skalnate Pleso* atlas. From west to east the galaxies include **NGC 4219** (Sc spiral), **NGC 4373** (E3 elliptical), **IC 3370** (E2 elliptical), **NGC 4507** (SB barred spiral), **NGC 4603** (Sc spiral), **NGC 4645** (E3 elliptical), **NGC 4679** (Sc spiral), **NGC 4696** (E1 elliptical), and **NGC 4767** (E5 elliptical). They range in brightness from **NGC 4373** at magnitude 12.2 to **NGC 4645** shining at only magnitude 13.1. Each is quite small indicating the best views will be had with medium-to-high powers.

The final open cluster in our survey is located in western Centaurus. **NGC 3680** is the home of some two dozen stars ranging from magnitude 10 to 14. Their light combines to an integrated magnitude of 7.6, making the group visible in a 3-inch scope. Distinguishing the cluster from random field stars can prove difficult due to its loose appearance.

As Halley leaves Centaurus on April 18th, it passes very close to **IC 3253**. This is a 12th-magnitude spiral galaxy measuring 3.3′ x 1.8′ across. Just over the border in Hydra is **NGC 4304**, a barred spiral that is also 12th magnitude. Each reveals a featureless disk amidst faint field stars. The latter galaxy has a 7th-magnitude star near its southeastern edge — don't mistake this star for a supernova!

The comet swings into **Hydra** on April 19th. Hydra, the Water Snake, is the longest constellation in the sky, covering one-fourth of the celestial sphere. Halley remains within Hydra until April 25th, only to return again about 10 days later.

M68 (NGC 4590) is northeast of Halley on April 20th. This is an 8th-magnitude globular cluster that Charles Messier discovered in 1780. His description noted only a nebulous glow, but modern-day amateur telescopes can do better. An 8-inch scope is sufficient to begin distinguishing some of M68's more than 100,000 cluster stars. The cluster is believed to be 9.6 kiloparsecs away and is approaching us at about 115 kilometers per second.

Closer to Halley at this time are seven faint galaxies. The most interesting are **NGC 4105** and **NGC 4106**, two elliptical galaxies (E3 and E2, respectively) that are physically interacting with each other. They almost seem to merge into one object at low power, but two separate spheres are visible with higher magnifications. NGC 4105 is larger and a half magnitude brighter than NGC 4106, so it will be spotted first. I am sure you will agree that, although dim, these two objects combine to create a curious sight.

Only three arcminutes east is **IC 764**. You may have to look hard for it, since IC 764 shines at only 13th magnitude and measures 5′ x 2′, giving the impression of a faint cigar-shaped cloud. Photographs show it to be a nearly edge-on Sc spiral. Another galaxy that might defy detection is **IC 2995**. Also a 13th-magnitude object, this SBc barred spiral measures 3′ x 1′, appearing as a miniature version of IC 764.

The comet's head might occult **NGC 3904** on the evening of April 22nd. Although it is fading, Halley will still be many times brighter than this 12th-magnitude elliptical galaxy. My 8-inch has revealed this object to me in the past as a nearly circular glimmer about 1.5′ x 1′ across. Perhaps you'll notice the brighter galaxy to the northeast. This is **NGC 3923**, which may just be visible in the same field of a low-power eyepiece. It shines at magnitude 11 and appears more oval than NGC 3904. I was unable to glimpse any hint of a central condensation in this E4 elliptical.

Farther north are **NGC 3885** and **NGC 3936**. The former is a 13th-magnitude S0 galaxy. Depending on your eyesight, it may be undetectable from a star in all but high power, since it only measures 1.7′ x 0.9′. NGC 3936 is equally faint but measures 4.0′ x 0.8′ across. Look for a long, thin spike when you seek NGC 3936. Both of these galaxies are difficult targets for backyard observers.

NGC 3621 is a little easier. This is an Sc spiral galaxy with a magnitude of 10.6. It may be seen as a moderately large oval glow measuring 5′ x 2′. Some sources refer to NGC 3621 as an Sd spiral, indicating that its arms are very widespread. Although this can not be checked visually in amateur instruments, it may be possible photographically.

NGC 3585, NGC 3673, and **NGC 3717** wind up our tour of this portion of Hydra. Each can prove to be an arduous task, with NGC 3585 the brightest at magnitude 10. The other two shine at blue magnitudes 12.3 and 12.2, respectively. Each of these galaxies gives the impression of a small oval patch of light with little detail detectable. A 7th-magnitude star lies just south of NGC 3673 and should be a help when star hopping to the galaxy.

Crater, the Cup, greets Halley on April 25th. It offers little to the naked-eye star watcher and little more to the telescopic observer. All 15 bright deep-sky objects in Crater are galaxies. **NGC 3672** is the brightest at blue magnitude 11.5. The others range from 12th magnitude down to magnitude 13.1. If finding faint galaxies is your specialty, then Crater is the place to be.

Fading rapidly, Halley's Comet crosses back into Hydra on May 3rd after passing very near α Crateris two nights earlier. About 7° west of the comet on the 3rd is **NGC 3242**, a fine planetary nebula glowing at 9th magnitude. NGC 3242 displays a distinctive pale blue disk, which aids greatly in its detection. Its 11th-magnitude central star is easily observable. Long-exposure photographs show a bright central portion 16″ in extent encapsulated by a fainter halo some 21′ across. Estimates place this object about 0.8 kiloparsecs away. If this is correct, then NGC 3242 has a real diameter of 0.2 parsecs.

By the time Halley crosses into **Sextans** on May 15th, it will have dimmed greatly. Very few objects await us in this small constellation. The most notable is **NGC 3115**, an E7 elliptical galaxy noted for its resemblance to a flying saucer. It is located about 19° south of Regulus and 10° east of Alphard [(α) Hydrae]. NGC 3115 shines at 9th magnitude and stretches out 8.3′ x 2.2′; its distinctive shape is striking in backyard telescopes. The comet makes its closest approach to NGC 3115 toward the end of May. The other galaxies in Sextans are fainter than 11th magnitude and, due to the lack of any nearby bright naked-eye stars, are difficult to hunt down.

As spring fades into summer, so Halley's Comet continues to fade from view. Its apparent motion will have slowed to a crawl, allowing the Sun to rapidly catch up. By August 1st, the comet crosses into **Leo** with solar glare coming perilously close. This signals the end of Halley's apparition for amateur astronomers since the comet will likely be too faint to see in our telescopes when it reappears in October's morning sky.

Enjoy Halley's Comet, *the* astronomical event of 1986. It will be quite a spectacle, especially from the southern latitudes. And while you watch it pass through the ever-changing celestial neighborhoods of stars, nebulae, and galaxies, don't forget to see, as the late Bart Bok so eloquently put it, "all of those good deep-sky objects in the southern sky."

Phil Harrington is an accomplished observer and author who resides just outside of New York City. His last article was "Deep-Sky Objects in Auriga and Gemini" featured in Deep Sky 13.

Small Scope Showcase

Big and Bright Galaxies

By David H. Levy

On Earth it means renewal, but for skygazers spring means warmer nights, galaxies, and globulars. Remember all those frigid times when you had to force yourself to confront Plutonian temperatures to observe your favorite Messier object? Not anymore! With spring, everything changes. (Of course, it's likely that you are reading this inside, which probably means the worst snowstorm of the year is taking place with no sign of clearing until a cold snap from Canada comes along.)

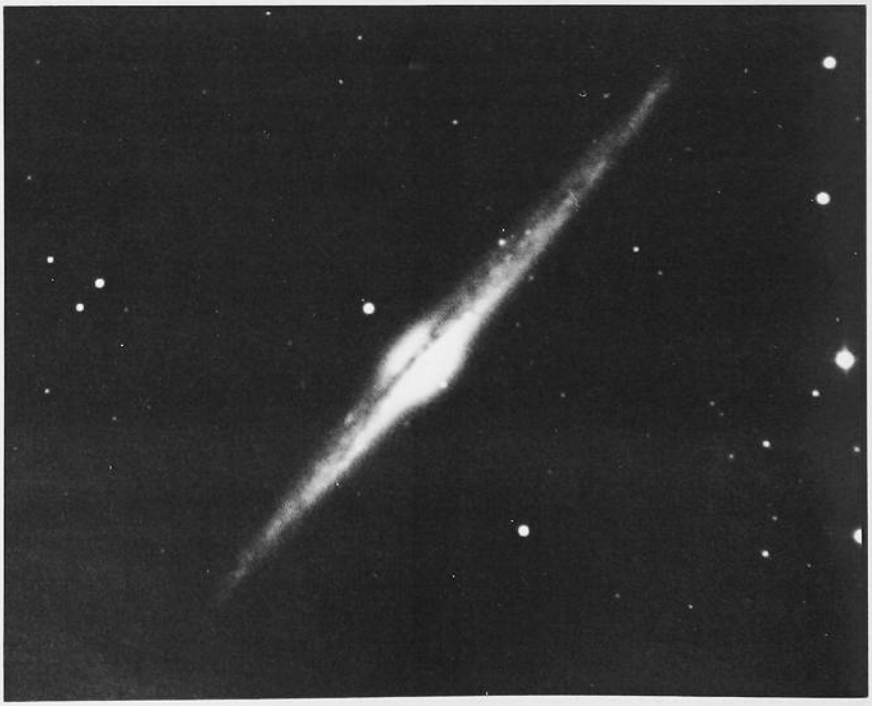
In any case, one of these nights the sky will clear to offer you a new look at that celestial representative of spring, **M51** (NGC 5194) — the Whirlpool Galaxy in Canes Venatici. This is a huge galaxy lying only 7.5 megaparsecs light-years away, and because it is oriented face-on it is a magnificent sight indeed. But there is more, for this galaxy has a companion called **NGC 5195**, which appears to be connected to one of the Whirlpool's spiral arms.

M51 is easy to find if you are observing under a dark sky. On the other hand, it's amazing how sensitive this particular galaxy is to the local whims of light pollution. From a typical suburban site, you won't see M51 through a finderscope and your telescope will probably show only a faint blob. A city sky obliterates the galaxy entirely — even through a telescope. But choice of location is not the only thing that affects the galaxy's image quality. The greater the atmospheric extinction, the poorer your view will be so wait until M51 is as high above the horizon as possible before looking at it.

What would M51 look like if we saw it edge-on rather than face-on? We can generate a reasonably accurate picture with computers, but the sky itself offers a close match about 25° away in the constellation Coma Berenices. After your look at M51, move to **NGC 4565** — a pencil-thin galaxy that lies edge-on to our line of sight. Under a dark sky this galaxy is always a thrill to view, but I think the joy is doubled if you have just looked at M51 for the two galaxies allow you to see the sky in three-dimensional terms.

These galaxies offer proof for the theory that 14th-century astronomers developed but could not show — that the sky is not a fixed sphere but an active, busy place in which a dynamic

The great spiral galaxy Messier 51 in Canes Venatici is visible as a twin patch of misty light in large binoculars and small scopes. A 6-inch scope shows subtle detail over the galaxy's face on dark, transparent nights. Photograph by Paul Roques using a 16-inch f/4.5 reflector, hypersensitized TP 2415 film, and a 45-minute exposure.



The edge-on spiral galaxy NGC 4565 in Coma Berenices is the finest example of its type in the entire sky. Small scopes show NGC 4565 as a silvery needle of nebulous light. A 6-inch telescope at high power is capable of showing the thin dark lane that bisects the galaxy's disk. Photograph by K. Alexander Brownlee using a 16-inch reflector.

Overshadowed by its impressive neighbor M44, the more diminutive open cluster M67 in Cancer is still a fine sight in small instruments. Astronomers categorize M67 as one of the oldest open star clusters known. Photograph by Jay Anderson using an 8-inch f/1.5 Schmidt camera, hypersensitized TP 2415 film, a red filter, and a 10-minute exposure.

universe unfolds. NGC 4565 is some 15.0 megaparsecs away and is part of a huge cluster of galaxies known as the Coma-Virgo group. By using any star chart that shows the huge concentration of galaxies in that area of the sky, simply sweep your telescope to pick up as many galaxies as you please. In some 1° fields, you may be lucky enough to count as many as seven or eight galaxies!

Moving our thoughts and eyes closer to home, let's examine and enjoy some objects in our galaxy beginning with the star cluster **M44** (NGC 2632) in Cancer, also called the Beehive. Finding this nice grouping of suns is easy — not because there are bright stars nearby but because the cluster itself is so brilliant.

On a clear night well away from city lights, the cluster shines as a large, misty spot and many astronomers — both amateurs and professionals — have misinterpreted it as a possible bright comet. (This should not be an embarrassment, especially if the cluster is low in the sky since Messier himself had to add it to his catalogue!)

It's interesting how certain clusters characterize themselves by their patterns of stars; some take on the shape of semicircles or arcs while others, like M44, form triangles. Just south of the Beehive is **M67** (NGC 2682), a smaller but tighter grouping of stars.

Spring is also the time to meet two of the finest globular clusters in the northern sky. Between Cor Caroli and Arcturus is **M3** (NGC 5272), a vast conglomeration of at least 30,000 stars that are located some 45,000 light-years away. M3 is an inspiring sight, a globular whose brilliance and beauty compete with the best of galaxies. And in Hercules lies **M13**, or NGC 6205 as it is known by its designation in Dreyer's *New General Catalogue*. This is the brightest globular cluster in the northern sky, shining at better than 6th magnitude. It also is one of the largest globulars, covering a full tenth-of-a-degree of sky with the light from its membership of more than 500,000 stars.

Located some 7.2 kiloparsecs away, M13 probably measures 37 parsecs across. Take a long look at it through the eyepiece of your telescope. Like M3, M13 orbits our galaxy as a satellite. There are two other vital facts you should know about this brilliant globular: The first is that it was discovered by Edmond Halley in 1716; the second is that it was discovered again by an eight-year-old girl at a summer camp a few years ago, as her first deep-sky object. "It's like — it's like a little fluffy ball," she opined, thus beginning a love affair with the sky that given proper care and nourishment could last a lifetime.

In late spring, a third glorious globular rises early enough to be seen by evening stargazers. **M5** (NGC 5904) in Serpens lies just northwest of the star 5 Serpentis. A full ¼° in apparent diameter, this cluster almost fills the field of a high-power eyepiece. M5 is a little larger and more distant than M13, and is especially thrilling in small scopes.

Near these clusters is a small constellation called **Corona Borealis**, the Northern Crown. This group of stars actually looks like a crown, a "circle citadel" of seven stars located between Bootes and Hercules. Corona Borealis is interesting because it contains two of the most fascinating variable stars (known as "R" and "T") in the entire sky."

Normally shining at 6th magnitude, **R Coronae Borealis** occasionally and without warning plummets eight full magnitudes so that it cannot be seen without a substantially large telescope. **T Coronae Borealis** is an exploding star that usually shines at a faint 10th magnitude. In 1866 and again in 1946, T arose from its slumber and climbed rapidly to 2nd magnitude to become a prominent part of the crown.

R and T are deep-sky members that lack the fuzzy appearance normally associated with deep-sky objects. But they make up for it with something different: both stars are subject to sudden, dramatic, and unpredictable change. Observe them long enough and you won't be disappointed.

Let's look in reverse order at the range of objects we have seen in this season's romp through the sky. We have gone from older single stars in our galaxy (the two variables in Corona Borealis) to a couple of young stars called open clusters. We have journeyed hence to the very edge of the galaxy and the strange realm of the globulars. And we have continued our quest beyond our galaxy to the island universes that are so omnipresent this season. In spring as nature paints a soft picture of life and renewal around you, the sky above you frames that picture with the hardwood of vastness and permanence.

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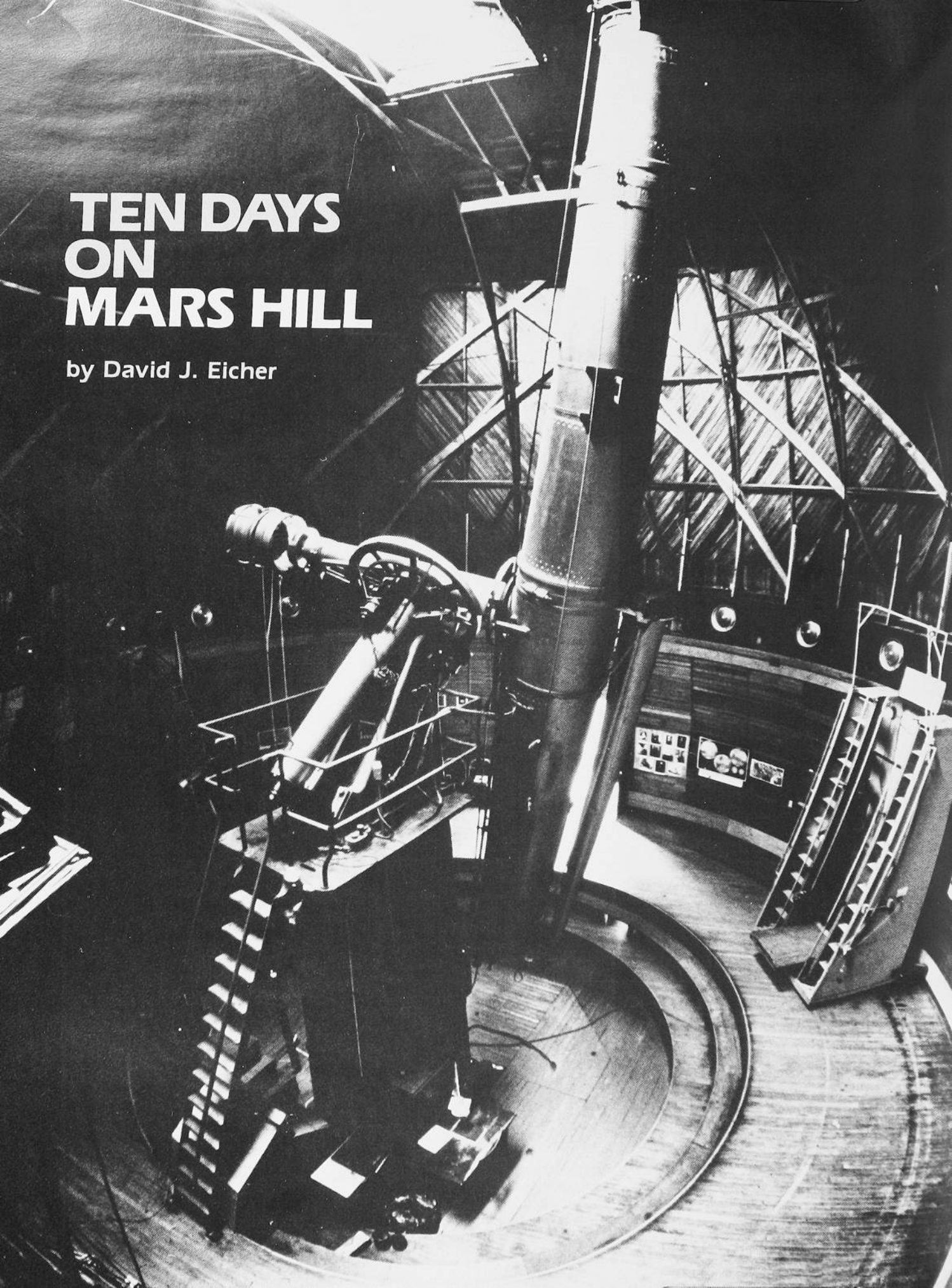
TEN DAYS ON MARS HILL

by David J. Eicher



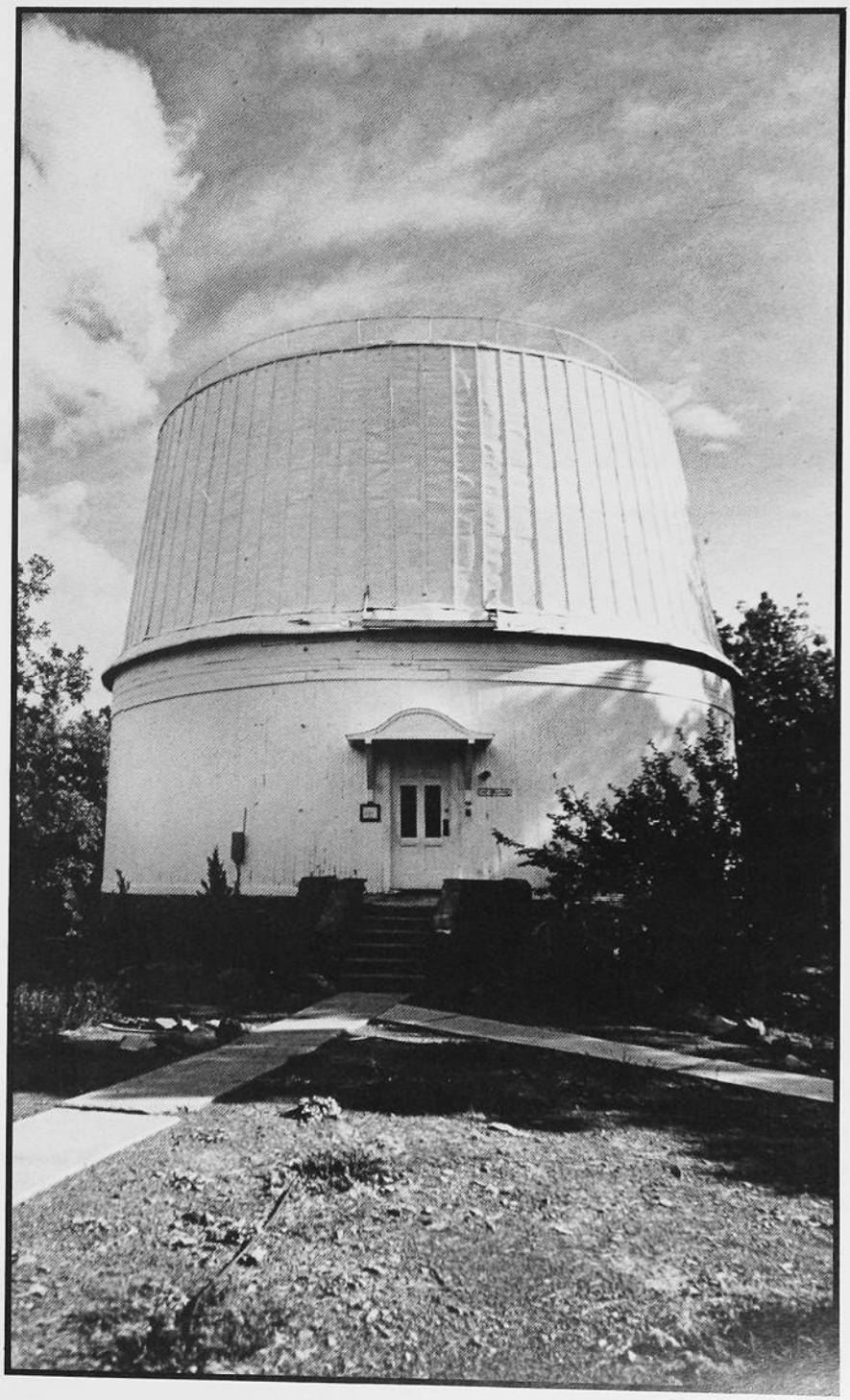
Early in 1985 my friend Brian Skiff, on behalf of Lowell Observatory, invited me to fly out to Arizona for a grand opportunity — a two-week jaunt as an astronomer at Lowell, one of the oldest and most historic observatories in the United States. Situated in Flagstaff on "Mars Hill" and surrounded by cool breezes and Ponderosa Pines, Lowell is an idyllic vacation setting. This chance to do some "real astronomy" and get a much-needed rest from writing and editing seemed the best thing I could possibly do.

So on Wednesday, September 4, 1985, I came to work for an hour, packed up my things, and headed for Milwaukee's Mitchell Field airport. Having spent most of my life in the Midwest, I was relieved to be heading for clear, dark skies. After a brief stopover in Minneapolis, the plane resumed its destination toward the Rockies. The flight was comfortable, and it was quite soothing to see the landscape change as we flew over the country's midsection. It had been cold and drippy in Milwaukee, but when I stepped off the plane in Phoenix and met Brian, it was a sweltering 96° F.

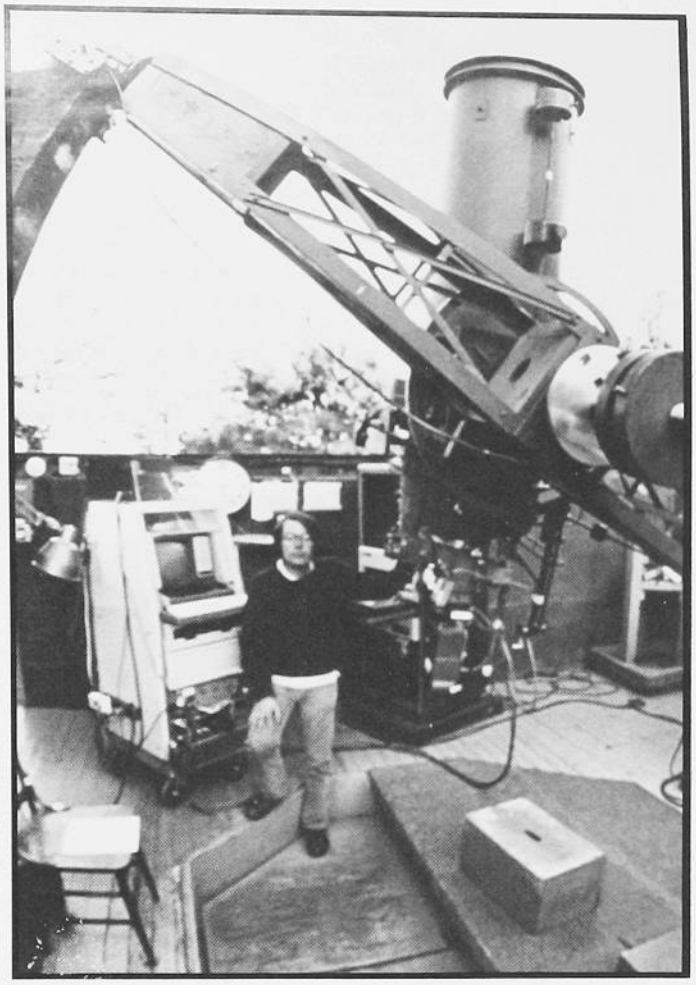
The two-and-a-half-hour drive to Flagstaff was relaxing: we saw the desert transform into a high-elevation mesa surrounded by mountains and peppered with beautiful landscape. We arrived at Brian's home, the "oldest inhabited house in Flagstaff," at 5:30 p.m. and soon after drove the kilometer up Mars Hill to the Lowell Observatory grounds. Having made it safely to Arizona, I had no greater ambition that first night than orienting myself around Lowell and trying to meet some of its astronomers. I had been to Lowell before, in 1981, but hadn't come to know many of its people. Brian introduced me to Bobby and Ellen Bus, a young couple whose energy and enthusiasm seemed endless. We talked to Larry Wasserman, a computer software expert who is a member of the Space Telescope astrometry team. I also met Ted Bowell, whose asteroid studies are invaluable to Brian Marsden and the IAU circulars.

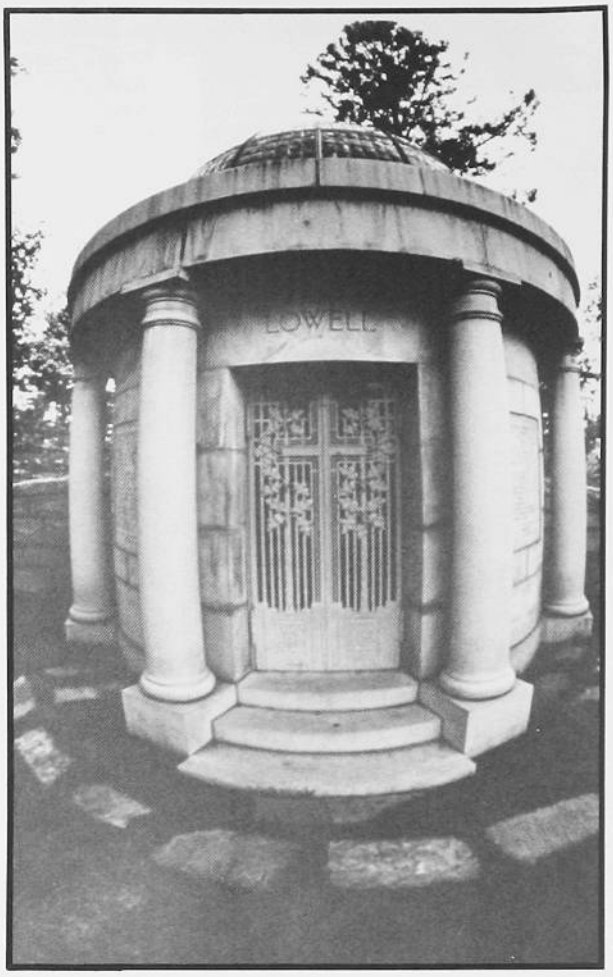
Thursday the 5th brought new opportunities, although I had trouble rousing myself until noon because of fatigue. At 2 p.m., Brian and I had lunch at Macy's Cafe, a favorite hangout in a town rampant with Northern Arizona University students. Later in the afternoon, we returned to Lowell. There I met Tobias Kriedl, a specialist in Ap stars, gas distribution in comets, and image processing; Wes Lockwood, whose specialty is spectrophotometry of solar system objects and solar variability; and Bob Millis, whose interests include comet photometry and asteroid occultations (Millis was involved in the discovery of the Uranian rings).

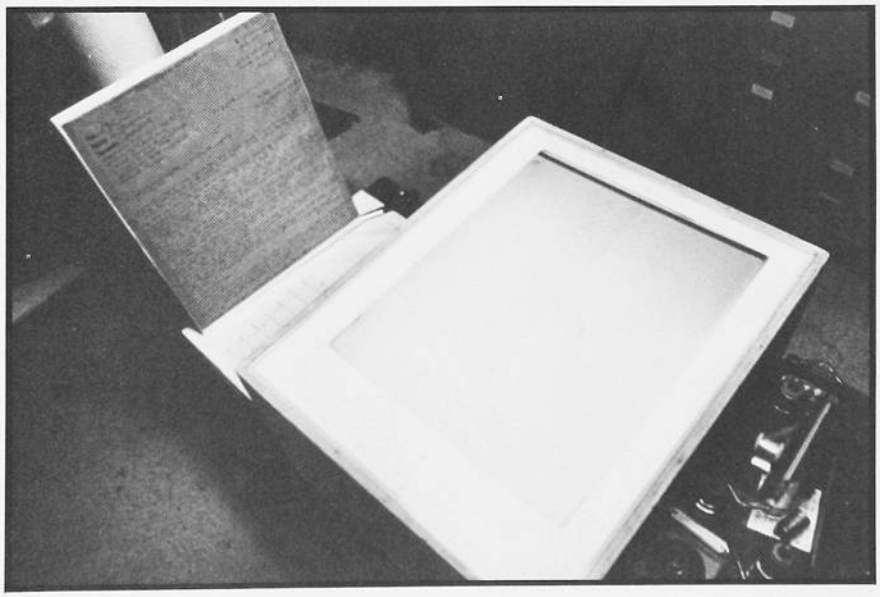
We had dinner back in town and then returned to Lowell for my first night of astronomy. It looked clear early on, and we all hoped that weather wouldn't let us down. Early in the evening the Buses opened the 24-inch f/15 Clark refractor dome and allowed me to observe with the telescope. This remarkable telescope cost Percival Lowell some $20,000 in 1896 and it remains largely as it was then, save for the addition of electrically operated instruments and hydraulic observing platforms. But even today the dome slits are opened using ropes. Operating the telescope was enjoyable and the images were crisp: Jupiter was a stunningly detailed and colorful disk, unlike anything I've ever seen in another telescope. I looked at M13 and the little galaxy NGC 6207, the Dumbbell Nebula, among other objects. By 10 p.m. we quit playing and resolved



Left: **A great wood-slatted dome looms over Percival Lowell's prized possession, the 24-inch f/15 Alvan Clark refractor with which he observed Mars and other celestial phenomena. Photograph by Brian Skiff.** ***Right:*** **The 24-inch refractor's dome reminds one of an oversized garden shed. This and all other photos in this article by David J. Eicher.**







Above left: Lowell astronomer Brian Skiff stands beside the 21-inch photometric reflector that he uses for high-precision photometry of solar-type stars. This telescope was used by Harold Johnson when he invented the UBV system of photoelectric standards. *Above right:* Lowell's will stipulated that he be buried in this tomb adjacent to his Clark refractor on Mars Hill. The appearance of the structure is distorted by a fisheye lens. *Left:* In the vault inside the main building's basement is the "B plate" made by Clyde Tombaugh in 1930, which he used with the "A plate" (now in the Smithsonian Institution) to discover Pluto. *Below:* A section of the jacket notes from the B plate reads: "Planet 'X' (Pluto) at last found!!!"

— C. W. Tombaugh
June 9, 1930

Notes of Examination: —
1. – 8 asteroids "A".
2. – 7 variable stars "V" (+3 or 4 others not marked on the plate — see plate 165 for this part.
3 – 12 temporary objects (on one plate only) which may be variable stars, novae, or defects.
two different suspicious objects (transneptunian) of 17th mags were found to be a variable star in both cases, from checks on other plates — on one plate a variable and a defect on the other).
4 – No comets
5 – Planet "X" (Pluto) at last found !!! P

to do some data gathering.

At 10:30 p.m. Brian and I went to the 21-inch photometric telescope, which is located "up the hill" from the refractor. This telescope was used many years ago by Harold Johnson to define the UBV system of photometric standards. It is now operated by two computers: a Digital Equipment Mini 1103 runs the telescope and a Heath machine automatically takes photometric data. Brian rolled off the roof, started a pop music tape for background noise, got the telescope "up and running," and began photometering his program stars. I watched.

After a while, Brian stepped aside and said, "We're on 61 Cygni. You do this one!" Having seen the procedure, I found the star in the photometer's previewer eyepiece, chose the correct diaphragm and filter, and did a 2-second integration. After the computer read my data, I moved the telescope off 61 Cygni A and read the sky. Then I photometered 61 Cygni B and the sky background. Then I did two comparison stars, pausing to do the sky after each. I was slow at first, but my data looked good and it was later used successfully by Wes Lockwood and Brian in their program to monitor solar-type stars for small variations in light output.

By about 2:30 a.m., the temperature had dropped to a chilly 42° and I was fading fast. Brian resumed his photometry at full speed and I retired to the Lowell reading room to take a nap. I lay on the couch and browsed through the room's books as I thought about my first night of photometry. I turned on a reading lamp; everywhere were tomes signed by their original owner, Percival Lowell, and dated in the late 19th century. I dozed off and awoke in a dream-like state an hour later to see the yellowish lamp's dim illumination on a portrait of Lowell, whose eyes gazed down intently. I don't think I'll ever forget that — startling is an inadequate adjective. Soon after I fully gained consciousness, Brian tramped in and suggested we get some sleep. After all, it was 3:45 a.m. and there was a big day ahead.

Friday the 6th began with breakfast at noon. By 1:30 p.m. we had arrived at Lowell and I joined one of the public tour groups to see how they're handled. Ellen Bus is responsible for showing around the 30 or 40 people who normally stop in during the afternoon to see what Lowell is all about. Visitors get to see the 24-inch refractor, the administration building, and the grounds. A slide show in the main building's rotunda describes the observatory's long history. Ellen's cheery attitude and expertise of what's happening at Lowell made the tour a pleasant experience and a good introduction to beginners in astronomy.

After the tour I was introduced to Bill Baum, the director of Lowell's Planetary Research Center. Baum was concerned about getting the borrowed Space Telescope CCD camera fitted properly on the observatory's 42-inch reflector at Anderson Mesa, located some 15 miles from Mars Hill. This week, after all, would mark the brightening of Comet Halley to 13th magnitude and the continued good visibility of Comet Giacobini-Zinner. The temporary research shift toward Halley was already under way. The rest of this cool breezy Friday was dedicated to learning about what was to come during the following week: cometary astronomy at the Mesa.

On Saturday the 7th I awoke at 2 p.m. and was delighted to discover the temperature at 62° and the sky partly cloudy but mostly dark blue. I took a brisk walk before returning to the house for breakfast. Afterward, Brian and I went up the hill and photographed the 21-inch photometric scope, which had served so well in initiating me to photometry. Next we went downstairs in the main building to the plate stacks where Brian had a surprise waiting. He showed me the collection of plates made by Carl Lampland, the Sliphers, Tombaugh and others, and then carefully removed from its sleeve the "B plate" that was used in combination with the "A plate" to discover Pluto. (The A plate is housed at the Smithsonian Institution.) We photographed the plate and studied it, the only obvious image being a horribly overexposed Delta δ Geminorum. The sleeve notes were terrific, the last line of which was "Planet X (Pluto) at last found!!!"

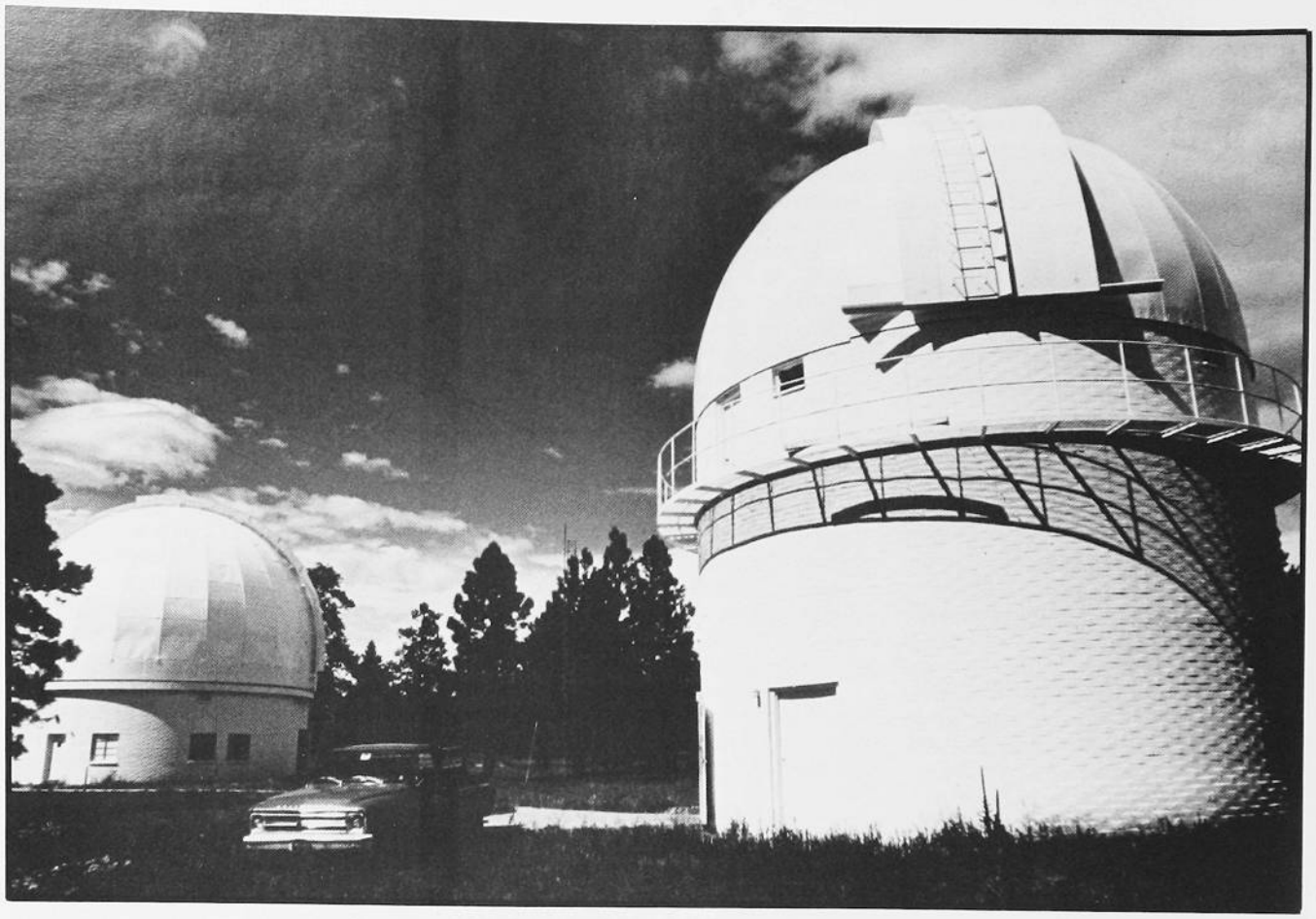
At dinnertime Brian and I went to Ernesto's, a famous local pizza establishment, and after digesting the feast went back to Lowell for more photometry of solar-type stars with the 21-inch scope. Brian and Wes Lockwood have been looking at stars like the Sun that are near us in the Galaxy to see if they exhibit small variability; they are also looking at the Sun itself with a radically stopped-down telescope. Studies of this sort may help to figure out exactly where in the scheme of stars the Sun fits. On this night I was again put to work, doing HD 215704 and several comp stars. After a time, Brian determined that the night was not photometric so we used the 21-incher for good ol' visual deep-sky observing. We stayed up quite late and looked at many objects, mostly galaxies, planetary nebulae, and open clusters. The views were some of the finest I've ever had.

Sunday the 8th was expedition day. Before noon, Brian and I took our cameras and headed north from Flagstaff bound for the Grand Canyon. We passed "the Peaks," the San Francisco Mountains that loom over Flagstaff like the *Hollywood* sign looms over Griffith Park. We passed Kendrick Peak, which Brian and I and several other astronomers had climbed in 1981. We drove off the plateau and down into the desert, not stopping until we reached the Canyon's South Rim at 2:00 p.m. From Yupapai Point, we photographed great stretches of Canyon that lay around us on three sides. But mainly we stood and looked, talked about geology, and climbed among the rocks to see how far down we could go before it was time to head back.

After returning to Flagstaff, Brian left for Lowell to get some work done while I went with astronomer Chris Luginbuhl to the U.S. Naval Observatory outside of town. The Navy's 61-inch astrometric telescope is phenomenally impressive; it is completely automated, computer-controlled, and has some of the finest machining and optics of any telescope in the world. Along with Chris, Dick Walker was kind enough to show me the entire operation of this mighty telescope, including the VAX computer that takes the data (and is superbly managed by Dave Monet) and the image processing facilities that the Naval astronomers use. I climbed way up inside the dome to photograph the telescope using a fisheye lens, then climbed down and viewed Jupiter and several other objects through the scope. Afterward, it was home to sleep.

Monday the 9th was a great day. After lunch, I went to Lowell and talked to a number of astronomers about their various research interests. I conversed with Henry Giclas, Lowell's history of science expert and proper motion researcher, and congratulated him on the rediscovery of Comet Giclas. By mid-afternoon I caught up with Bob Millis, who is actively involved with many projects. He is primarily doing occultation programs of stars by asteroids, stars by comets, and predictions of upcoming events for astronomers around the world. Millis is also actively pursuing cometary photometry, an area he's pursued since Comet West, in cooperation with astronomer Mike A'Hearn. Says Millis of the current state of things: "We can do from the ground what used to be done from spacecraft."

At 9 p.m. we went to the Mesa to use the "Pluto camera," more properly the 13-inch Lawrence Lowell astrograph, which was used by Tombaugh in 1930 to discover Pluto. Brian wanted to take astrometric plates for Ted Bowell's asteroid program of determining orbits and discovering new objects. The plan was to make several 30- or 40-minute exposures of fields containing or likely to contain asteroids, but the sky was partially cloudy and getting worse.



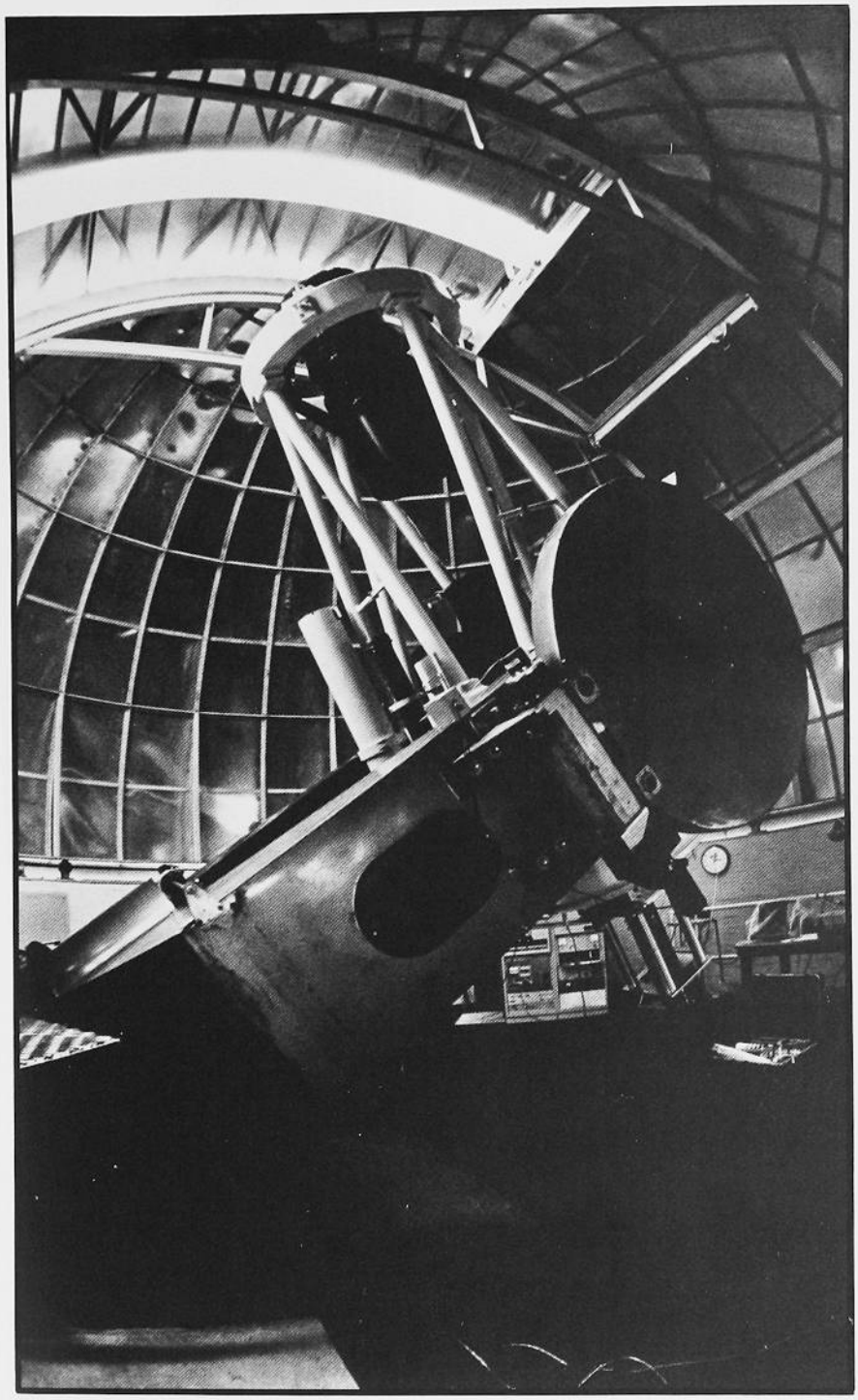
Above: **Lowell Observatory operates its large telescopes under dark skies at Anderson Mesa, located some 15 miles from Mars Hill. Here are the 72-inch reflector (left) and the 42-inch reflector, which I had the opportunity to use for observing and data gathering.** ***Left:*** **A 60-minute star trail photo shows Jupiter and the southern Milky Way over the 42-inch dome.** ***Opposite left:*** **The 42-inch Cassegrain telescope through which I first saw Halley's Comet.** ***Opposite top:*** **The Pluto camera dome on Anderson Mesa.** ***Opposite center:*** **The Mark IV Space Telescope CCD camera set up on the 42-inch reflector.** ***Opposite bottom:*** **A view of the 42-inch scope from below.**

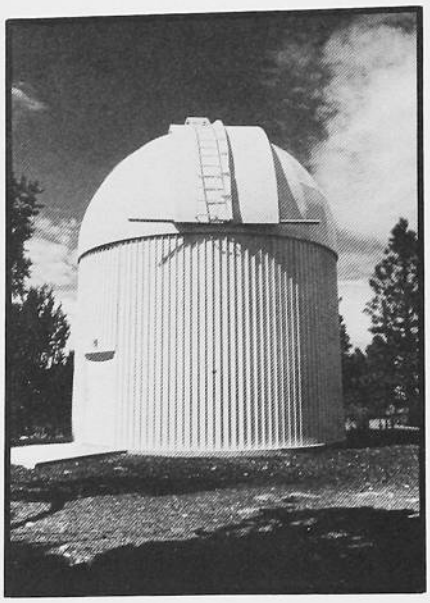
We looked at Jupiter and a couple of double stars, but by 10:30 p.m. we were forced to shut down.

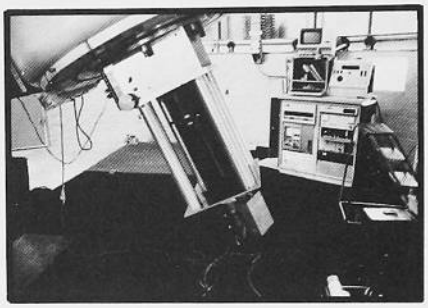
Tuesday, the 10th of September, brought special excitement to Lowell Observatory: the Astro-1 mission astronauts, scheduled to fly on the Shuttle in March and study Comet Halley using UV telescopes, arrived in town for a colloquium. Waking at 10:30 a.m., I had breakfast and then went out to the Mesa with Brian to watch the installation of the Space Telescope CCD on the 42-inch reflector. Riding out with Bill Baum, we discussed galaxies and his time spent at Palomar with many astronomers including Edwin Hubble. That night, we went to the 42-inch to do asteroid and comet photometry using the CCD camera but aborted by 10:30 p.m. because of a faulty board in the computer that controlled the CCD photometer. New parts had to be driven in from the Jet Propulsion Lab in Pasadena.

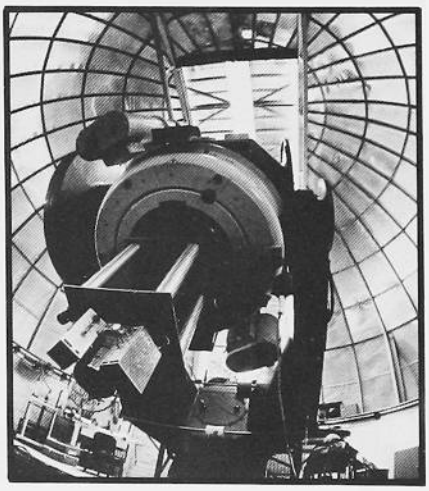
On Wednesday morning the 11th Brian and I heard about the ICE encounter with Giacobini-Zinner. I went up the hill to meet Art Hoag, the observatory's director. We talked for a long time about the observatory, his projects, and his activity in galaxy research over the past 25 years. He showed me historical guest books dating back to the 1890s that were filled with the signatures of virtually all the notable astronomers of this century. Then we took each other's photo standing next to Lowell's portrait. Afterward, I went off to have lunch.

Brian had offered to speak on comets to a local astronomy group on Wednesday night, so we drove about 25 miles south of Flagstaff to Sedona, a quiet community situated amidst outcrops of reddish rock. The Sedona Astronomy Club was enthralled to hear the latest on comets and Comet Halley.





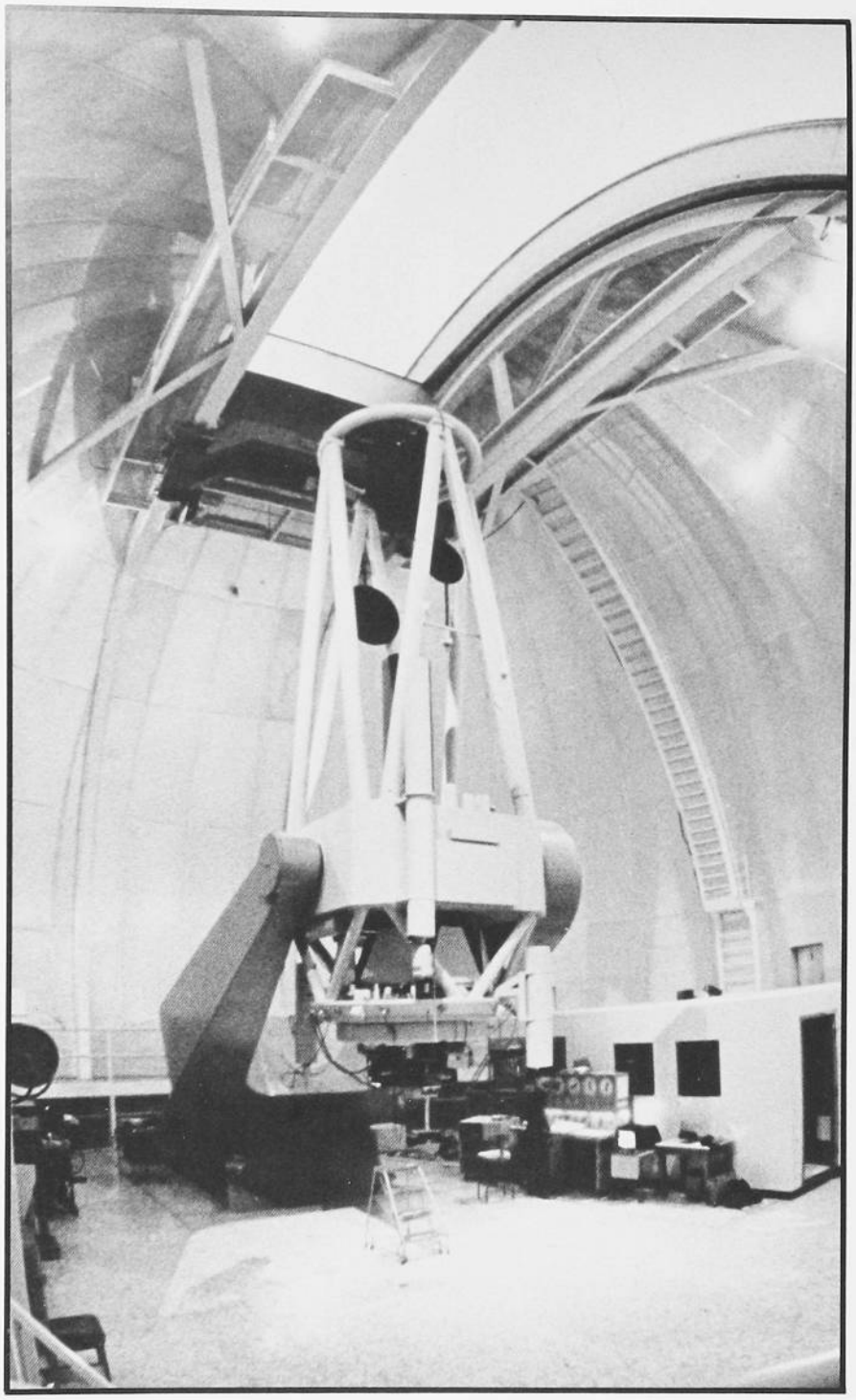


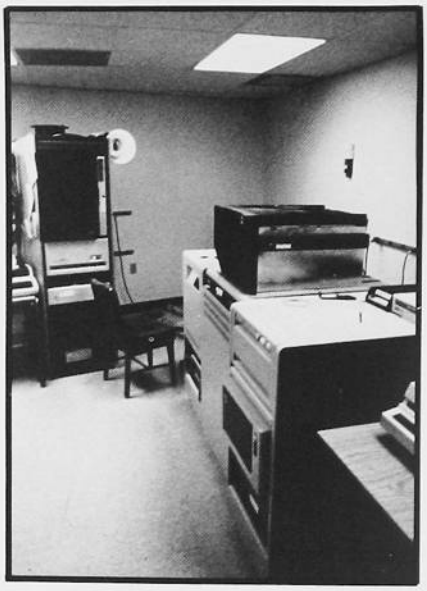


Afterward we drove back to Flagstaff and went straight to the Mesa to photograph with the Pluto camera. Guiding the Pluto camera was a little like pulling teeth: the exposures were 30 or 40 minutes long, the guide stars rather faint, and my unaccustomed eyes started playing tricks on me after 20 or 25 minutes of staring into the crosshairs. But we obtained some plates of asteroid fields despite the fact that the temperature had dropped below freezing — uncharacteristically cold for midnight in September in Flagstaff.

After exposing several plates, we headed back to the 72-inch scope where the Astro-1 astronauts were observing with several of Lowell's astronomers. We decided to visit the less populated 31-inch scope farther down the mountain where Bob Millis and the Australian astronomer Peter Birch were doing photometry. When we arrived, we discovered that Millis was working on photometric standard stars so a glimpse of Halley's Comet would have to wait. The 42-inch scope had been shut down, however, because of a tape drive malfunction. And all we'd have to do to use it would be enter the dome and turn on the computers.

By about 2:30 a.m., we made it back to the 42-inch and opened the dome. This massive telescope is typical in design and appearance to many of today's medium-sized professional telescopes. Standing underneath it as it whirred and buzzed was a fascinating experience. By 3:00 a.m. we had the telescope operating and found Comet Giacobini-Zinner. It was very bright and had a tail that extended for several field diameters. A few minutes later we caught our first glimpse of Halley, a fuzzy 13th-magnitude patch of light resembling a large planetary nebula or small circular galaxy. Finally around 4:30 a.m., after looking at various deep-



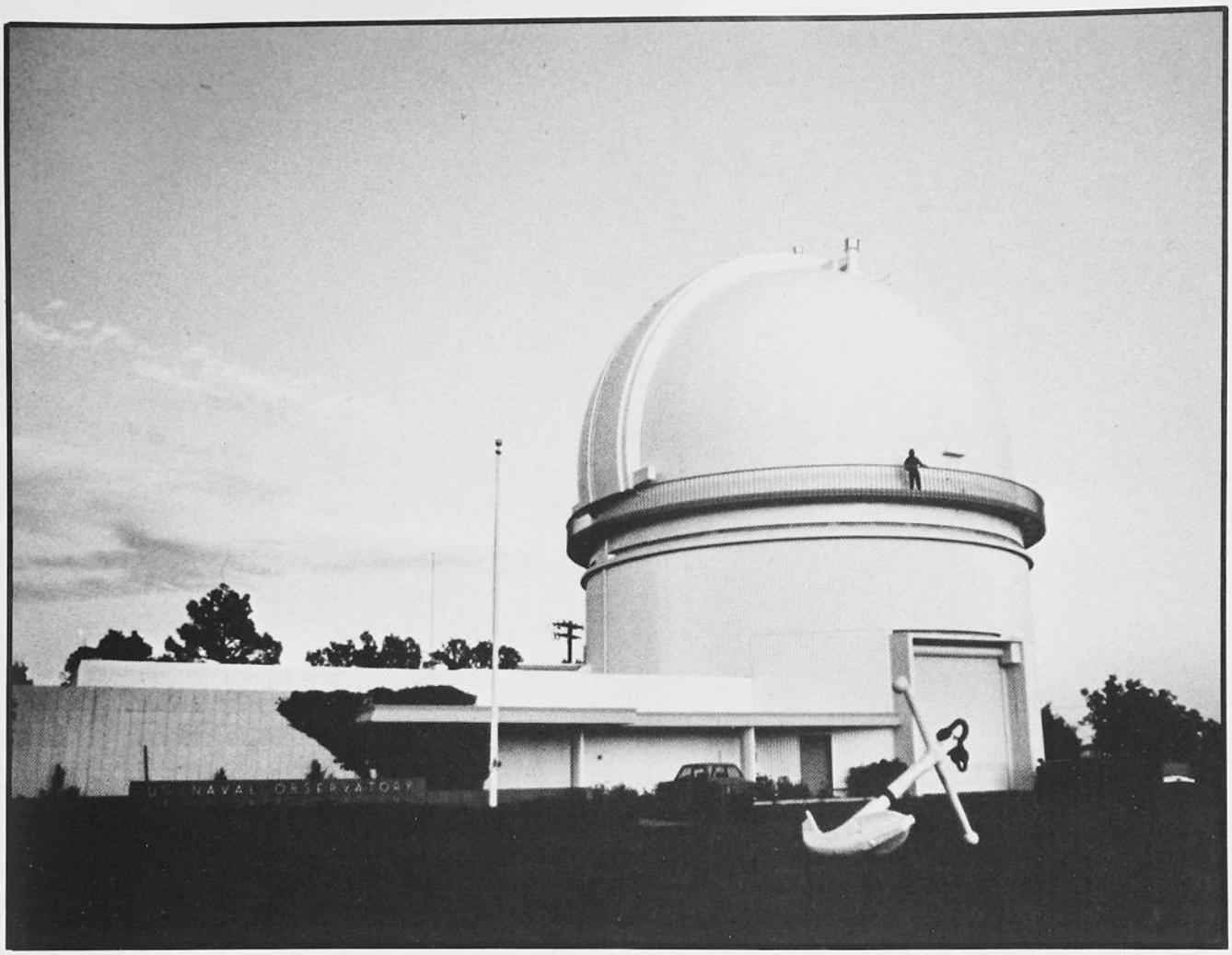


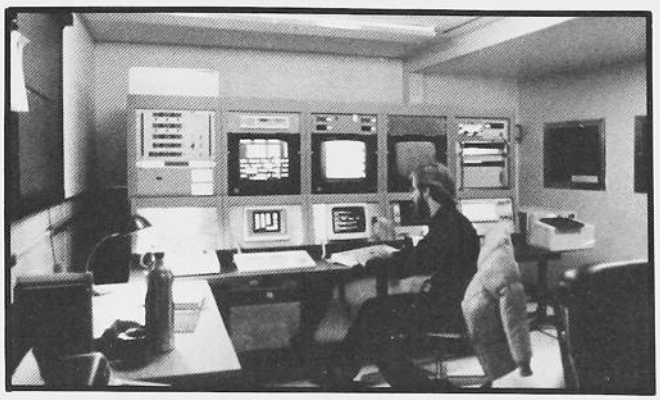
Left: The 61-inch astrometric reflector at the U.S. Naval Observatory's Flagstaff Station, located some 30 minutes outside of town. Here Chris Luginbuhl and Dick Walker showed me the entire operation; we viewed Jupiter and several other objects through the telescope. *Above:* The Digital Equipment VAX computer used for data collection from the 61-inch scope. *Opposite top:* Luginbuhl stands on the catwalk for this picture of the dome made at sunset. *Opposite bottom left:* Luginbuhl (left) and Walker stand at the control panels of the 61-inch, one of the foremost computer-controlled telescopes in operation. *Opposite bottom right:* Chris provides a demonstration of the control instruments and imaging computers inside the operations center of the 61-inch scope.

sky objects with the big scope, we headed home for sleep.

Thursday the 12th was a rather quiet day, beginning at 1:00 p.m. with lunch in the Lowell reading room. The astronaut colloquium wouldn't start for an hour, so I hiked around the grounds and photographed domes, buildings, people, and Flagstaff from Mars Hill. Returning to the Planetary Research Center, I walked into a lavish reception for the astronauts and joined in talking to and photographing them. Also present were guests such as Frank Edmondson from Indiana University and his wife Margaret, who is the daughter of Henry Norris Russell. The presentation was given by all the astronauts and mission specialists, but the show really belonged to Jeff Hoffman, who showed movies of his escapades with experimental toys in the Shuttle and fixing defunct satellites using a "fly swatter" made on the spur of the moment.

On Friday the 13th, I relaxed and talked to various astronomers at Lowell. Late in the day, Bobby and Ellen Bus joined Brian and I for dinner at Swenson's, a local eatery stocked with amazing ice-cream sundaes. After consuming sandwiches and the largest desserts I've ever seen, I went to the Lowell administration building to do some paperwork and Brian drove off to the Mesa to make astrometric plates of asteroid fields. Around midnight, the Buses opened the 24-inch refractor and we looked for Comet Hartley-Good, which had been photographically discovered just two nights before. We had heard about Comet H-G during the day and had a position but didn't know what to expect. I found Hartley-Good in the 24-inch Clark, recorded its magnitude at 12.5, sketched its elongated shape, and contributed my observation to the IAU circulars via Ted



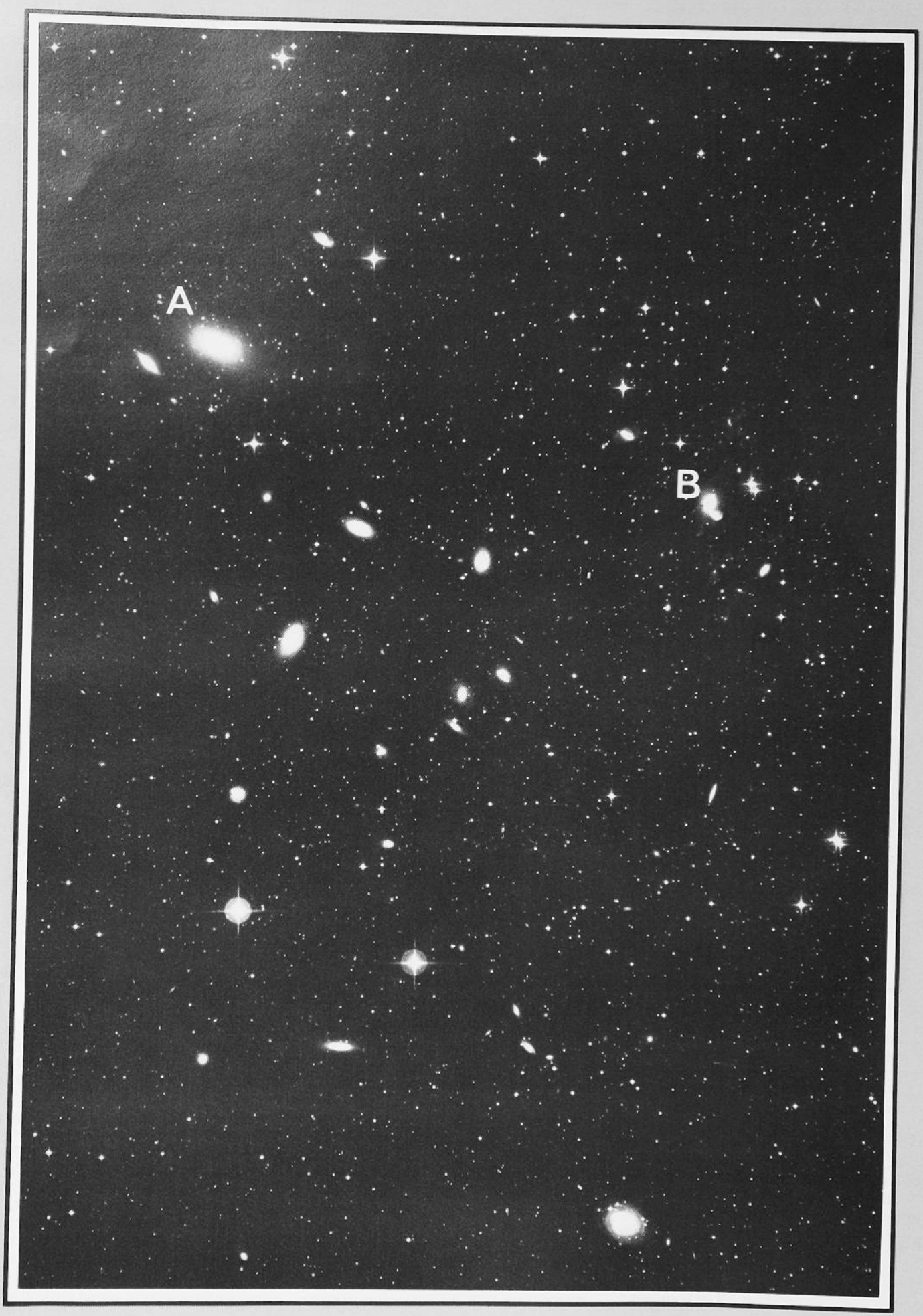


Bowell. As a final exercise, I sketched M42 with the Clark through intermittent clouds. The detail was stunning and the number of tiny nebular variables that were visible was amazing. By 4:00 a.m., I was asleep.

The next day was Saturday the 14th, my last full day in Flagstaff. I spent the day recovering from my crazed schedule of all-night observing, trying to rest up enough to work at full clip upon returning to Milwaukee. I went to downtown Flagstaff, picked up film that was developed, bought some magazines for the return flight, and recalled everything that had happened during my 10 days on Mars Hill.

It seemed like I had been there a long time; I had been introduced to photometry, CCD imaging, asteroid astrometry, historical astronomy, astronauts, and some of the finest telescopes and people working in astronomy today. I wished that I had more time to spend there in the serene atmosphere of cool breezes and towering mountains, pines, and aspens. It had been a great time, a great opportunity for tasting professional astronomy in the 1980s, for getting a first look at Comet Halley, for contributing numbers to the never-ending data dump of science.

As I flew back from Flagstaff to Phoenix and from Phoenix to Milwaukee on Sunday, I didn't think about the scopes or the comets or the numbers or the mountains. I thought back to the first night of observing in the roll-off roof observatory at the 21-inch photometric scope. As dusk approached and passed it got so very dark and the stars kept getting brighter, almost creating an illusion of being in space. This is why people get interested in astronomy and come to observatories, I thought. The thrill of standing under a brilliant star-filled sky and thinking about the future.


A
B

Observing the IC 4329 Cluster of Galaxies

by Jeff Corder

One of the greatest delights to backyard observers is discovering something totally unexpected. Many of us have happened upon a bright uncharted "star" only to have our excitement quelled when the new discovery turns out to be one of the brighter asteroids, or even Uranus or Neptune. Many deep-sky observers have been surprised to find one or two extra galaxies in a field where they believed only one existed.

Recently while surveying the region east and south of M83 in Hydra, I unexpectedly came across a field of at least six galaxies. I set out to observe only one galaxy, IC 4329 (which is plotted on popular star charts), but was delighted to see *five* more around it.

Having moved to Florida (at the latitude of 26° north), I found the constellation Centaurus far more conveniently placed for serious observing than it had been from my former residence in Illinois. Since February 1985, I have observed the IC 4329 cluster of galaxies (mostly situated south of IC 4329) extensively with an open-tubed 12.5-inch f/6 Newtonian. In an area about 1° across lie at least 15 galaxies brighter than photographic magnitude 16. I find this region quite interesting, and encourage observers to give this little-known cluster of galaxies a workout.

The IC 4329 galaxy cluster has long been the subject of scrutiny by professional astronomers. It contains IC 4329A, one of the most extreme Seyfert galaxies known. This galaxy is a strong x-ray source and has only recently been explored in depth. Another member — NGC 5291 — is also an unusual system. This galaxy has a close peculiar companion and contains galaxy-sized HII regions, the largest discovered to date.

This stunning photograph from a U.K. Schmidt plate shows the heart of the IC 4329 galaxy cluster in Centaurus. Several dozen galaxies are visible in this photo, the brightest of which are visible using backyard telescopes. (A = NGC IC 4329; B = NGC 5291.) Photo courtesy Russell D. Cannon, U.K. Schmidt Telescope Unit.

A good place to begin an exploration of this cluster is at its very heart, where the brightest galaxy lies. This is **IC 4329**, a 12th-magnitude galaxy easily visible in 6-inch telescopes. Suspected of being a weak x-ray source, IC 4329 is lenticular-shaped and classified as an S0-type galaxy; it appears very bright and elongated almost east-west, measuring nearly 90″ x 50″ in a 12-inch scope. It also has a bright elongated core 25″ x 20″ in size and contains a small, bright, nonstellar nucleus.

Possibly the most interesting galaxy in the IC 4329 cluster lies just 3′ northeast of IC 4329. This S0 system, known as MCG 5-33-021, has recently acquired the identity **IC 4329A** because it is a near neighbor to IC 4329. Visually, IC 4329A is a highly compressed, high-surface brightness galaxy, glowing at 14th magnitude. In the 12.5-inch scope it appears some 40″ x 30″ across with a small, easily visible nucleus.

On long-exposure photographic plates, IC 4329A exhibits both spiral and Seyfert characteristics. A prominent dust lane runs the length of the galaxy and it also contains an unresolvable, bright nucleus. The energy expended by this strong Seyfert is so high that it approaches that characteristic of quasars!

Moving your telescope 8′ east of IC 4329A will show a very faint, small, roundish galaxy. This is 15.5-magnitude **MCG 5-33-023**, yet another S0 system. I noted its diameter to be only 20″, so use high power! Take note of the galaxy's bright stellar nucleus and a faint star nearby to the southeast.

Now move southward from the IC 4329 area and you'll encounter the bright Sb-type spiral **NGC 5298**. This is the first of only five NGC galaxies to be found in the central environs of this cluster. Visible in the 12.5-inch with some faint field stars to the east and west, I found NGC 5298 to have an elliptical shape measuring 70″ x 40″ and an orientation of northeast-southwest. No obvious nucleus was detected, but the spiral contains a bright roundish core about 12″ in diameter.

South of NGC 5298 one encounters yet another spiral system: **MCG 5-33-010**. This galaxy is pretty dim, even in the 12.5-inch, and is surrounded closely on all sides by five faint stars. I found it to be slightly oblate in p.a. 10°. The system measures 40″ x 35″ in extent and contains a small bright center. South of NGC 5298 you'll find a spiral near a 12th-magnitude star. This is 13th-magnitude **NGC 5302**, one of the brighter cluster members. It seemed to me close to visual magnitude 13.5 and appears elongated nearly north-south, measuring about 60″ x 40″ in size with a bright core.

Moving westward, passing MCG 5-33-010 one again, you'll see a fairly bright double star whose components are nearly equal and are separated by about 15″. Just over 2′ east of this double is the peculiar and massive lenticular galaxy NGC 5291. This is the brightest galaxy in a nice interacting pair located on the outskirts of the IC 4329 cluster. Astronomers have discovered a system of 24 HII regions in NGC 5291, mostly aligned north and south of the galaxy.

The most intriguing feature of the HII regions in **NGC 5291** is their incredible size. Recent studies by English and Australian astronomers reveal that some of the HII complexes exceed the entire Large Magellanic Cloud in size and luminosity! Here again, amateurs have the opportunity to observe a highly unusual galaxy with backyard telescopes.

NGC 5291 is fairly faint, shining at magnitude 14.2. You'll find it small and round, only about 30″ in diameter, with

The IC 4329 Galaxy Cluster

Object	Type	R.A. (2000)	Dec.	Mag.	Size	Inc.
MCG 5-33-01	Sc?	13h43.41′	−30°37.8′	16.0	2.0′x0.2′	100°
anon.	Sb	13h44.31′	−30°22.4′	—	1.0′x0.1′	165°
MCG 5-33-05	—	13h44.32′	−30°10.0′	—	—	—
NGC 5291	S0a	13h44.33′	−30°09.5′	14.2	1.1′x0.7′	168°
NGC 5292	Sa	13h44.48′	−30°41.5′	14.0	2.6′x2.3′	55°
anon.	Sb	13h45.09′	−30°33.8′	—	1.0′x0.4′	46°
MCG 5-33-09	—	13h45.18′	−30°18.0′	16.0	—	—
MCG 5-33-10	Sa	13h45.20′	−30°12.2′	15.0	1.4′x0.9′	166°
MCG 5-33-11	Sa?	13h45.24′	−30°19.7′	15.5	1.3′x0.4′	56°
NGC 5298	Sb	13h45.45′	−30°10.8′	14.1	1.8′x0.9′	69°
MCG 5-33-14	S0	13h45.48′	−30°33.8′	15.0	1.9′x0.5′	88°
IC 4327	Sb	13h45.53′	−29°58.1′	12.8	1.3′x0.7′	57°
MCG 5-33-17	S0a	13h45.57′	−30°54.4′	15.0	1.3′x0.2′	135°
NGC 5302	Sa	13h45.58′	−30°15.8′	13.2	2.2′x1.2′	153°
anon.	Sb	13h46.09′	−30°22.6′	—	1.0′x0.9′	—
IC 4329	E/S0	13h46.14′	−30°02.9′	12.6	3.5′x2.4′	63°
MCG 5-33-20	S0	13h46.18′	−30°55.0′	15.0	1.9′x0.8′	170°
IC 4329A	S0	13h46.28′	−30°03.7′	14.2	1.6′x0.4′	45°
NGC 5304	S0	13h47.10′	−30°19.8′	14.6	1.5′x1.1′	146°
MCG 5-33-23	S0	13h48.02′	−30°02.5′	15.5	1.2′x0.2′	135°
MCG 5-33-24	Sb	13h48.17′	−30°32.0′	15.0	1.8′x1.1′	123°

Column 1: object designation in *Revised New General Catalogue* by J. Sulentic and W. Tifft, *Index Catalogue* by J.L. E. Dryer, or *Morphological Catalogue of Galaxies* by H. Nilson. **Column 2:** revised Hubble type. **Column 3:** coordinates for epoch 2000.0. **Column 4:** V magnitude. **Column 5:** size in arcminutes. **Column 6:** tilt inclination.

a bright center.

A peculiar companion to NGC 5291 is barely visible, seemingly attached to the south. This is **MCG 5-33-005**, the "Seashell Galaxy." The Seashell got its unusual name because of its bizarre appearance on a U.K. Schmidt Sky Survey plate. The Seashell shows signs of strong tidal interaction with NGC 5291 and exhibits a tail and distorted spiral appearance.

From studies of the NGC 5291/MCG 5-33-005 pair and IC 4329, astronomers have worked out a fairly reliable estimate of their distances. Assuming the Hubble Constant is 75 km/sec/Mpc, the distance works out to 55 megaparsecs.

Sweeping southeastward from NGC 5291, you should encounter a faint trio of galaxies that lie in a line oriented northwest/southeast. The first member of this trio is **MCG 5-33-009**. Little is known about this galaxy, but its published magnitude is 16. This seems impossibly faint, but I did actually see it in the 12.5-inch telescope on two occasions. With a diameter less than 30″, the galaxy contains a core slightly brighter than the surrounding fuzz.

About 1′ east of MCG 5-33-009 is another faint galaxy. Brighter than its neighbor, this one — which has no clear identification — is still somewhat difficult in the 12.5-inch scope at 145x. It appears elongated in p.a. 20° and measures some 45″' x 35″' visually.

The third member of this trio, located to the southeast, is **MCG 5-33-011**. A magnitude 15.5 spiral, it seemed much elongated in about the same p.a. as its anonymous neighbor. I found it near the visual limit of the 12.5-inch telescope.

Continuing eastward more than 25′, you'll encounter another easy target — this is the S0-type spiral **NGC 5304**. I found it bright and elongated in p.a. 150° with a trio of faint stars close to its southern end. One faint star can be seen just below the southern tip, as noted by J.L.E. Dreyer in the NGC. NGC 5304 measures 45″ x 30″ and brightens fairly evenly toward its center.

In the same low-power field as NGC 5304 is **MCG 5-33-024**. This is an Sb-type spiral with a bright field star less than 30′ southwest. Elliptical in shape, this system measures only about 35″ x 25″ and is relatively faint, gradually brightening in the center. I noted a very faint star close to the northwest tip of this galaxy.

Now direct your telescope westward and slightly north and you will come across two bright field stars. Just southwest of them lie two thin and faint galaxies. The western member, **MCG 5-33-014**, is lens shaped and oriented in p.a. 70°. This galaxy measures only about 30″ x 10″ and careful observers will note a nucleus slightly brighter then the surrounding nebulosity. The northeastern anonymous companion is somewhat fainter.

A final object in the IC 4329 cluster is the bright spiral **NGC 5292**. This Sa-type galaxy is located about one low-power field of view southwest of MCG 5-33-014. NGC 5292 is one of the easiest objects in this cluster and shines at about 14th magnitude. I found it to appear slightly out-of-round in p.a. 55°, and fairly large and bright. The galaxy measures some 50″ x 45″ visually and contains an easily visible nucleus. On one occasion, I noted an extremely small and faint anonymous galaxy about 1′ west-northwest. It seemed somewhat elongated but was only glimpsed with averted vision. Photographs confirm the existence of this tiny galaxy.

You may wish to continue searching for other faint galaxies in this region. To the south, you'll find the nice pair **MCG 5-33-017** and **MCG 5-33020**. Just beyond the western boundaries of the IC 4329 cluster, other challenging faint galaxies await including **IC 4324**, **IC 4321**, **IC 4319**, and 13th-magnitude **NGC 5264**.

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This sketch shows principal members of the IC 4329 cluster. The largest galaxy is IC 4329 at top; to its left is IC 4329A. The pair of galaxies at upper right is composed of NGC 5291 and the "Seashell," MCG 5-33-005. Sketch by Jeffrey Corder using a 12.5-inch telescope.

Observers using large-aperture telescopes may also see several of the extremely faint and small anonymous galaxies, which appear in photographs of the region. In a 17.5-inch Dobsonian, I discerned at least a dozen of these. They looked like little "fuzzy stars" — a truly memorable sight.

I hope observers will find the IC 4329 cluster as enchanting and absorbing as I have. This region in Centaurus, full of faint stars, makes galaxy-hunting a challenging and rewarding sport. My attention is drawn here time and time again throughout the cool spring months. Remember, the sky is full of such delights just awaiting discovery!

Jeff Corder, a long-time observer of galaxies and other deep-sky objects, lives near Fort Myers in southern Florida. His last article in Deep Sky *was the two-part series "Observing Low Surface Brightness Objects" in* DSM *6 and 7. Several of his excellent sketches of nebulae and galaxies appear in the forthcoming book* Deep Sky Observing With Small Telescopes.

DSM Reports

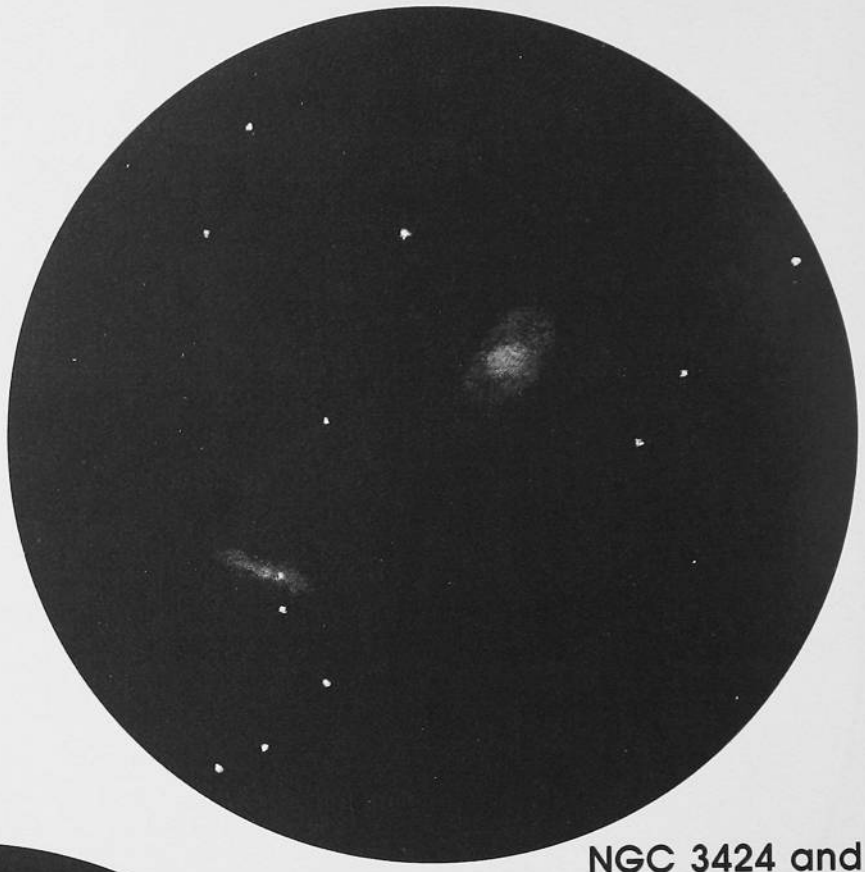
All sketches by Jay Albert

Galactic Treasures in Leo the Obscure

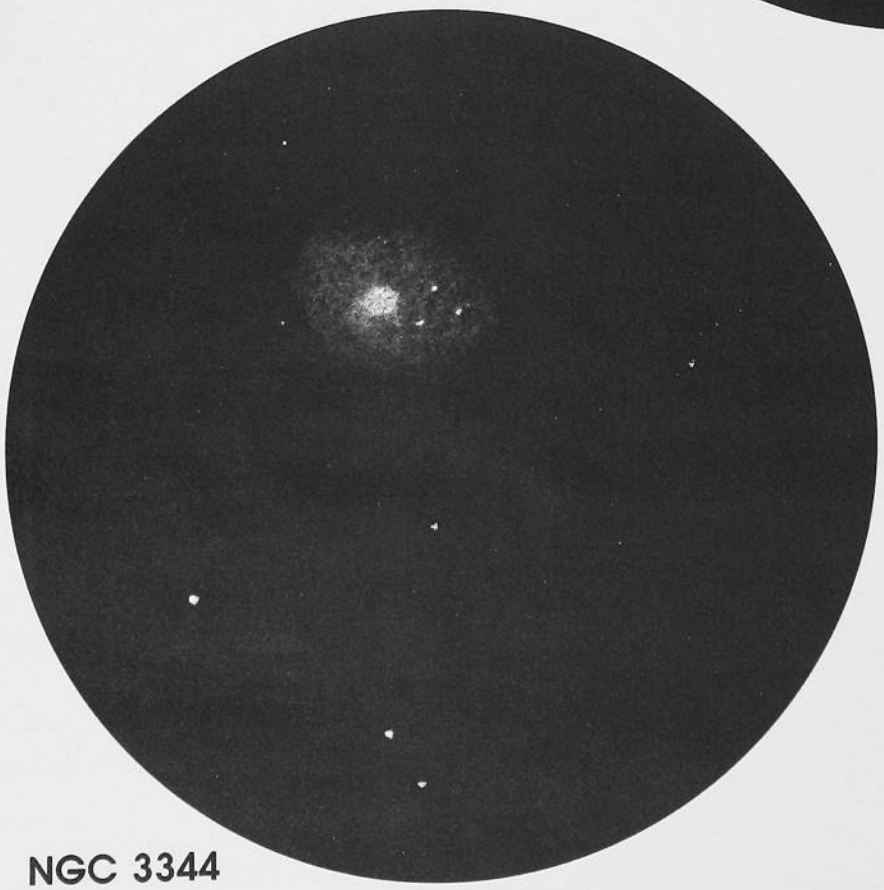
by Jay Albert

Just for a moment, consider Leo Minor. Can you remember the last time you observed anything in that constellation? It's small, as constellations go, and pretty faint. This little patch of sky is practically lost between the splendors of Ursa Major and Leo. it contains no stars brighter than 4th magnitude. Why, there isn't even an α Leo Minoris! If all that weren't bad enough, Leo Minor holds no Messier objects, no star clusters, and no nebulae. It might as well be called "Leo the Obscure."

Before relegating Leo Minor to the celestial trash heap, however, let's consider some of the goodies it does have. Leo Minor contains five variable stars listed in *Burnham's Celestial Handbook*, three of which vary by over three full magnitudes. *Sky Catalogue 2000.0*, volume 2, lists 26 double stars and Burnham's lists 21. Since the lists do not precisely match, a double star observing project might prove both challenging and interesting.



NGC 3424 and NGC 3430



NGC 3344

It was my galaxy sketching project, however (see *Deep Sky* #10), that ultimately brought me to this figurative cosmic backwater. Burnham's lists 20 galaxies in Leo Minor. One of those listings, 13th-magnitude NGC 3158, is the brightest of a group of eight galaxies. There are also 20 galaxies plotted for Leo Minor on Chart 6 of Tirion's *Sky Atlas*: five are west of 9h55m r.a., 14 are east of 10h30m r.a., and one lies between these two bunches. All are north of 24° declination, making them good targets for dark skies in the Northern Hemisphere.

In suburban New Jersey, such skies are hard to come by. Nevertheless, I have observed nearly all of these galaxies and would like to show you my favorites. To aid in reproduction for this article, all the sketches presented have somewhat higher contrast than my originals. All observations were made with an f/10 11-inch SCT and a Lumicon Deep Sky filter on nights when the transparency was good enough to reveal 5th-magnitude stars using averted vision.

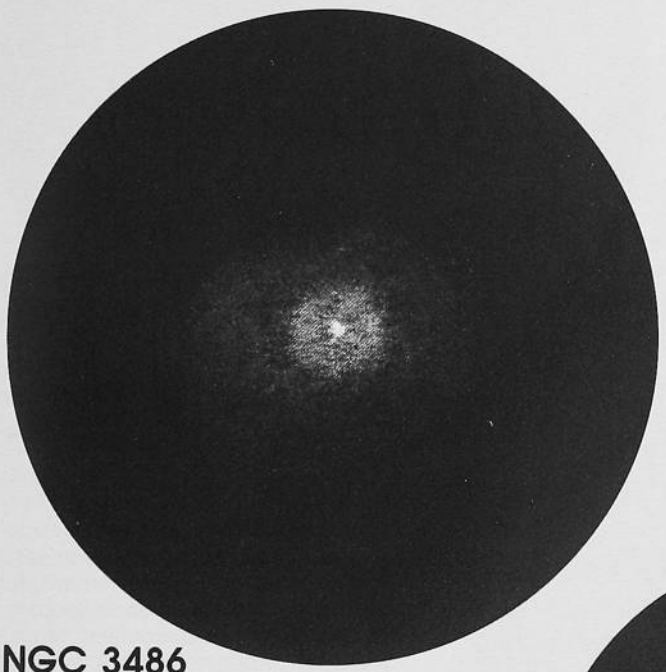
Here are some notes of my visual impressions:

NGC 3003 appears large with a

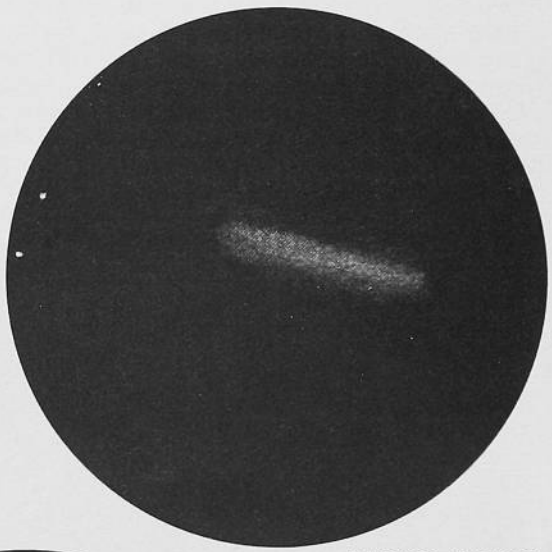
Galaxies in Leo Minor

Object	Type	R.A.(2000.0)Dec.	Mag.	B-V	SB	Size	Distance
NGC 3003	Sbc?	9h48.6m 33°25′	11.68	0.47	14.5	5.9′ x 1.7′	19 Mpc
NGC 3294	SA(s)c	10h36.3m +37°20′	11.7	0.51	14.0	3.3′ x 1.8′	20 Mpc
NGC 3344	(R)SAB(r)bc	10h43.5m +24°55′	9.95	0.55	14.5	6.9′ x 6.5′	7 Mpc
NGC 3395	SAB(rs)cd pec	10h49.8m +32°59′	12.1	0.29	13.2	1.9′ x 1.2′	20 Mpc
NGC 3396	IBm pec	10h49.9m +32°59′	12.2	0.44	13.8	2.8′ x 1.2′	20 Mpc
NGC 3424	SBb:?	10h51.8m +32°54′	—	—	—	3.0′ x 0.9′	19 Mpc
NGC 3430	SAB(rs)c	10h52.2m +32°57′	11.50	0.65	14.4	3.9′ x 2.3′	20 Mpc
NGC 3432	SBm sp	10h52.5m +36°37′	11.25	0.48	14.0	6.2′ x 1.5′	8 Mpc
NGC 3504	(R)SABab	11h03.2m +27°58′	11.1	0.70	13.6	2.7′ x 2.2′	20 Mpc
NGC 3512	SAB(rs)c	11h04.0m +28°02′	12.4	0.65	13.9	1.7′ x 1.5′	18 Mpc

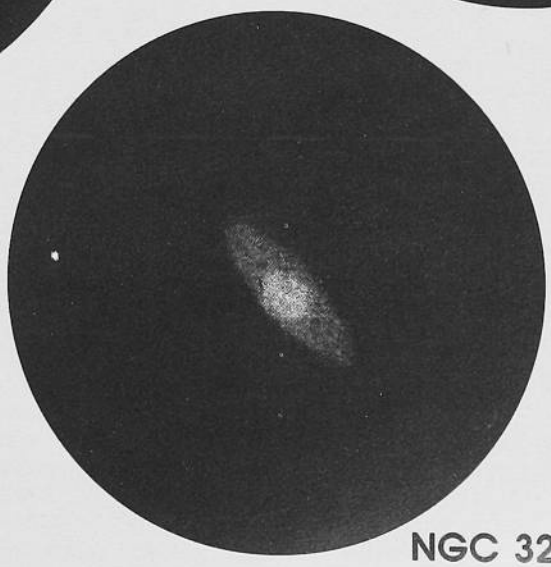
Column 1: designation in *Revised New General Catalogue* by J. Sulentic and W. Tifft, Univ. of Arizona Press, 1973. **Column 2:** revised Hubble morphological type. **Column 3:** coordinates for epoch 2000.0. **Column 4:** V magnitude. **Column 5:** B-V color index. **Column 6:** surface brightness in magnitudes per square arcminute. **Column 7:** angular sizes in arcminutes. **Column 8:** computed distance based on H_0 = 75 km/sec/Mpc. Data from *Second Reference Catalogue of Bright Galaxies* by G. de Vaucouleurs, A. de Vaucouleurs, and H. Corwin, Univ. of Texas Press, 1976. Compiled by D. Kendzie-Holdaway.



NGC 3486



NGC 3003



NGC 3294

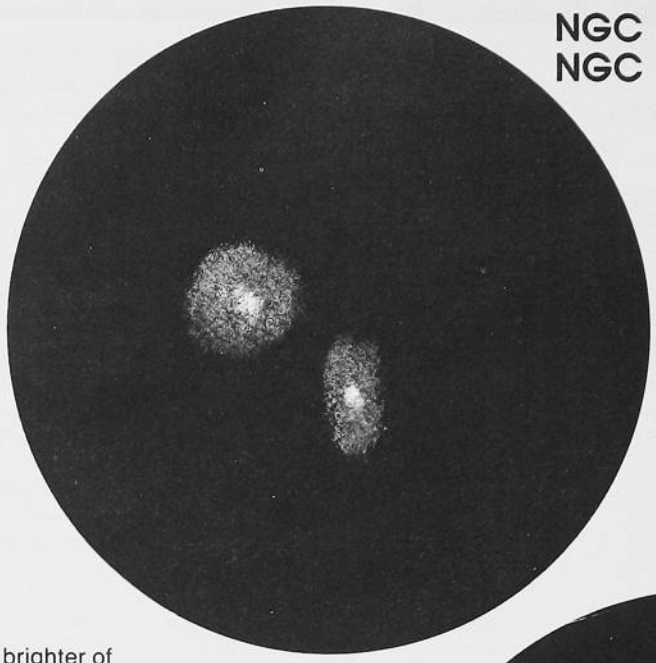
uniform disk elongated roughly east-west; shows no significant brightening.

NGC 3294 is large and elongated northwest-southeast; looks somewhat grainy with a gradually brighter middle.

NGC 3344 has a faint disk requiring averted vision; appears slightly brighter in the eastern and western portions. Disk is almost round, elongated roughly east-west, with a bright middle. Three stars are involved in nebulosity east of the galaxy's center.

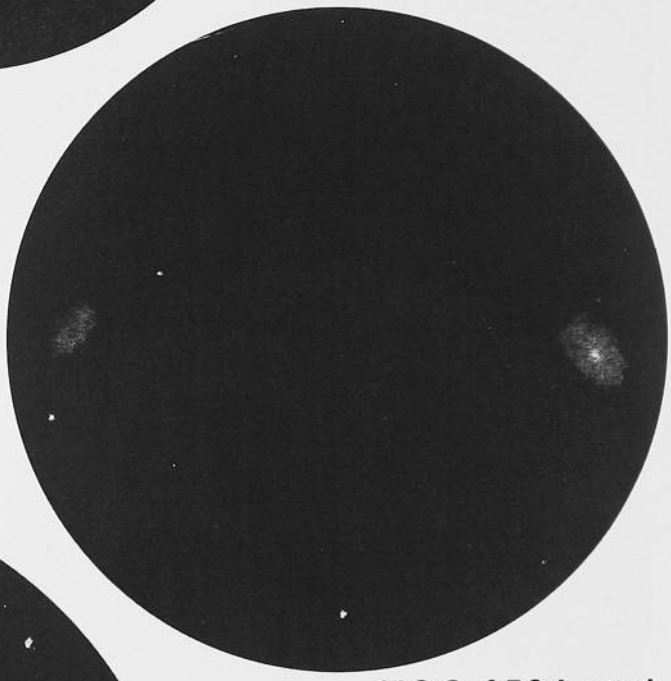
NGC 3395 and NGC 3396 look like two little eyes, one being slightly closed.

NGC 3395 and NGC 3396



NGC 3395 is the bigger and brighter of the two and is round (I couldn't see the northern and southern extensions that show in the photos in Burnham's) with a compact, brighter middle. NGC 3396 is elongated roughly west-northwest/-east-southeast with a suddenly brighter middle.

NGC 3424 and NGC 3430 a very pretty pair. The latter is the biggest and brightest of the two. It is oval-shaped with elongation northeast-southwest and has a gradually brighter middle. NGC 3424 (not plotted on Tirion's) is



NGC 3432

NGC 3504 and NGC 3512

highly elongated northwest-southeast with a compact, slightly brighter middle and brighter field star embedded in nebulosity just east of center.

NGC 3432 has a very bright, mottled disk elongated northeast-southwest with a round, slightly brighter middle. Three field stars lie either in or at the edges of nebulosity. Mottling of the disk is especially evident at 311x.

NGC 3504 and NGC 3512 are two fine galaxies. The former is the bigger and brighter of the pair with a hint of mottling in the disk. It is elongated roughly northwest-southeast with a bright, stellar nucleus. NGC 3512 appears as a faint oval aligned roughly north-south with no apparent central brightening.

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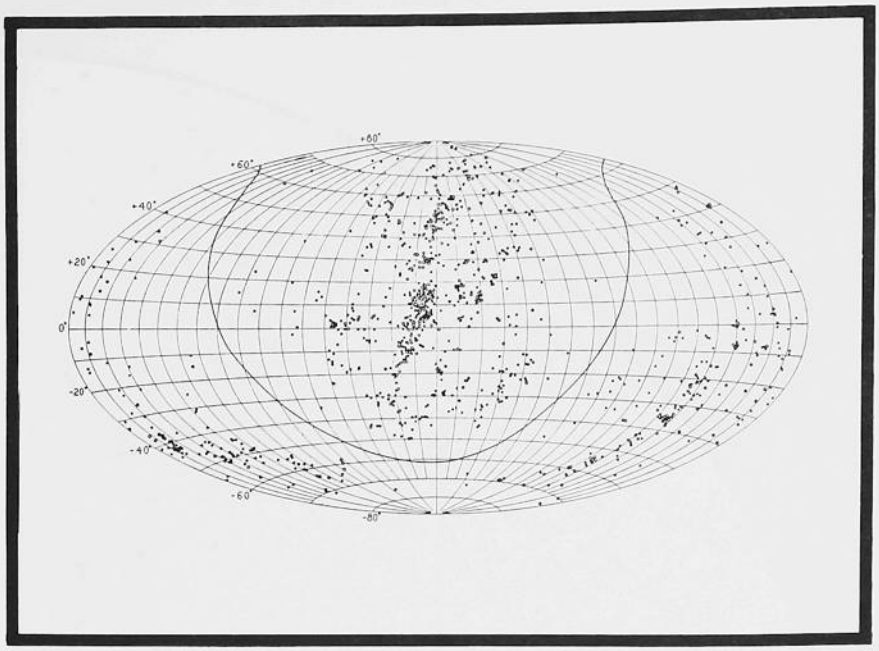
Plotting the RNGC, Part 2

by Richard Berry



This Aitoff projection of the entire sky shows the distribution of the 1,000 brightest galaxies; note that most are aligned in a north-south axis running through 12 hours right ascension. From *The Inner Metagalaxy* by Harlow Shapley.

In *Deep Sky* 13, we presented an equidistant cylindrical project of the entire sky showing all the objects listed in the *Revised New General Catalogue* as dots. Now, here in Part 2, we'll take a look at galaxies in the Northern Hemisphere. The map on the following two pages shows all galaxies in the north galactic hemisphere that are listed in the RNGC. *Only* galaxies are shown. The chart is centered on the north galactic pole, and is an azimuthal equidistant projection. It shows a circle of sky somewhat less than 180° in diameter.

The Virgo Cluster is nearly central in this plot. The main cluster appears elongated north-south in a roughly 2:1 ratio. An extension continues to the south, perhaps doubling the long axis of the cluster. To the north, the density of galaxies cuts off abruptly. The much fainter dots of the Coma Cluster appear to the northwest of Virgo. The swath of bright galaxies that comes down through Ursa Major and Canes Venatici — so apparent on the Skalnate Pleso charts — makes up the northern extension of the supergalaxy.

Supergalaxy? The supergalactic axis, extending from the top to the bottom of the chart, practically leaps off the page at us. It had not been so obvious to astronomers in the past, but, of course, they lacked the knowledge (which we take for granted) that the thing exists.

William Herschel's son, John Herschel, was himself the observer who completed the southern extension of his father's General Catalogue, the forerunner of Draper's NGC. John had this to say: "The great power of [William's] telescopes disclosed the existence of an immense number of these objects [galaxies] before unknown, and showed them to be distributed over the heavens, not by any means uniformly, but with a marked preference for a certain district . . . occupying about one-eighth of the whole surface of the celestial sphere, one-third of the entire nebulous contents of the heavens are congregated." (This passage is from article 868 in *Outlines of Astronomy*, 1902 edition.) In this place, at least, he seems not to have picked up on his father's suspicion — see Harold Corwin's letter in this *DSM* — that the nebulae might form a separate system of external galaxies.

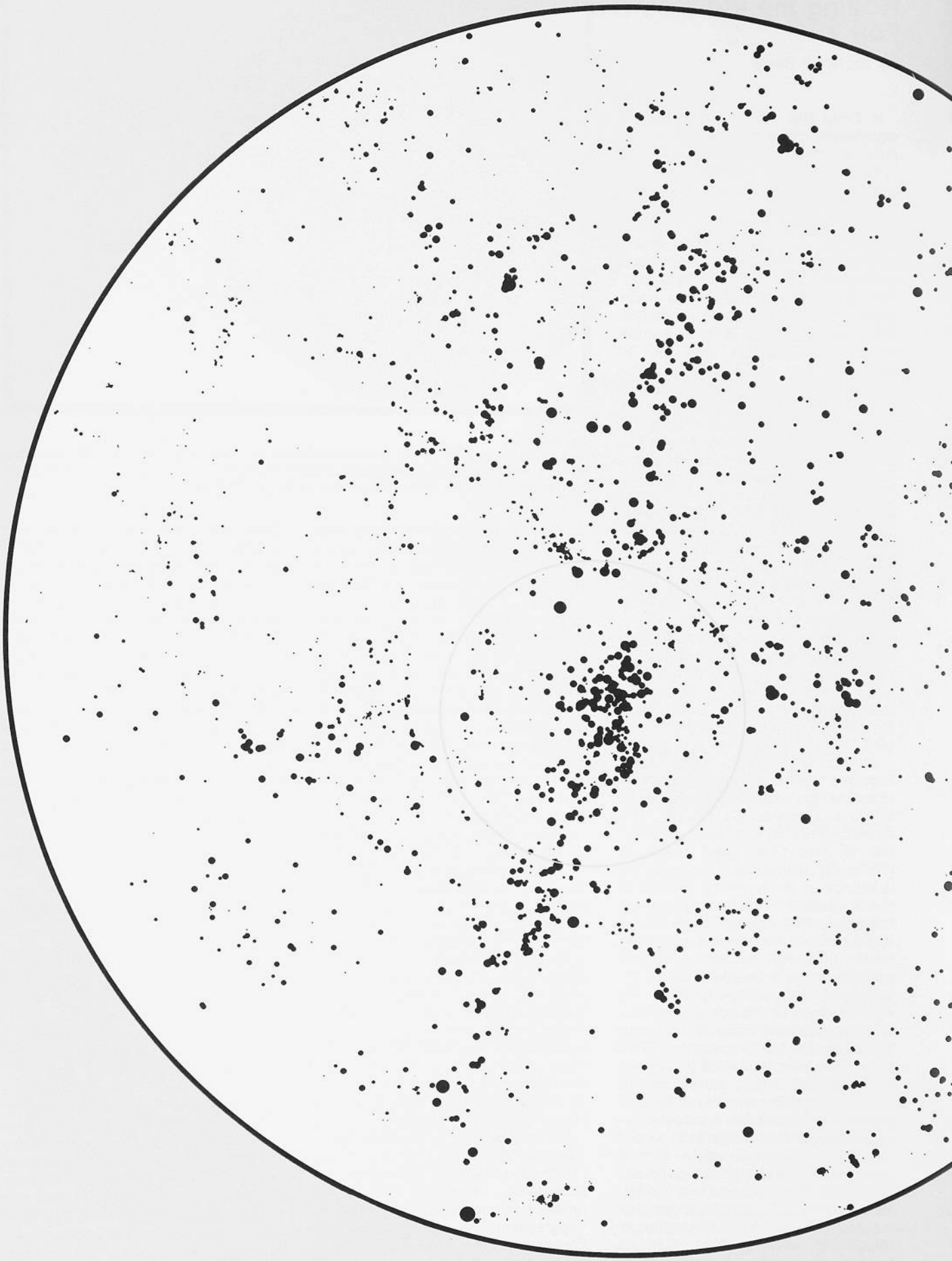
In *Other Worlds Than Ours* (Collier, 1902), Richard Proctor, in a complex argument based on the distribution of Herschel's nebulae, asks: "Can we suppose that, owing to some strange accident, external galaxies have been placed always opposite the barest regions of the sidereal system? Or setting aside such a notion as obviously incredible, are we to imagine that, when searching over these barren regions, the astronomer has a better chance of detecting nebulae than where the stars are more richly strewn, because the sky is less filled with glare?" Rejecting this notion, he presents his own bright idea: ". . . the nebulae in a sense represent the missing stars; that the region where those nebulae appear has been drained of star material, so to speak, in order to form them." So much for the notion of external galaxies!

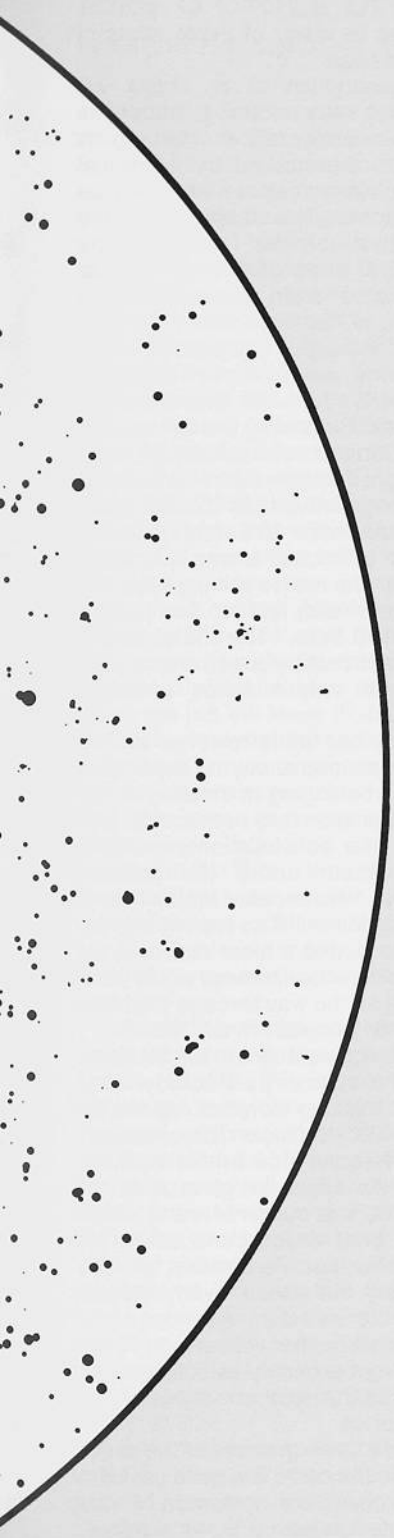
Edwin Hubble, writing in *The Realm of the Nebulae* (Yale, 1936), states: "Uniform distribution thus appears to be the most plausible interpretation of the nebular counts. At any rate, it may be stated that the distribution is uniform within the uncertainties of the data, and that the uncertainties are small." It seems understandable that the man who finally realized our galaxy contains great amounts of absorbing material, thus complicating terribly the task of exploring the universe, should find it difficult to accept that galaxies themselves might be equally perverse by being spread throughout space in a highly non-uniform manner.

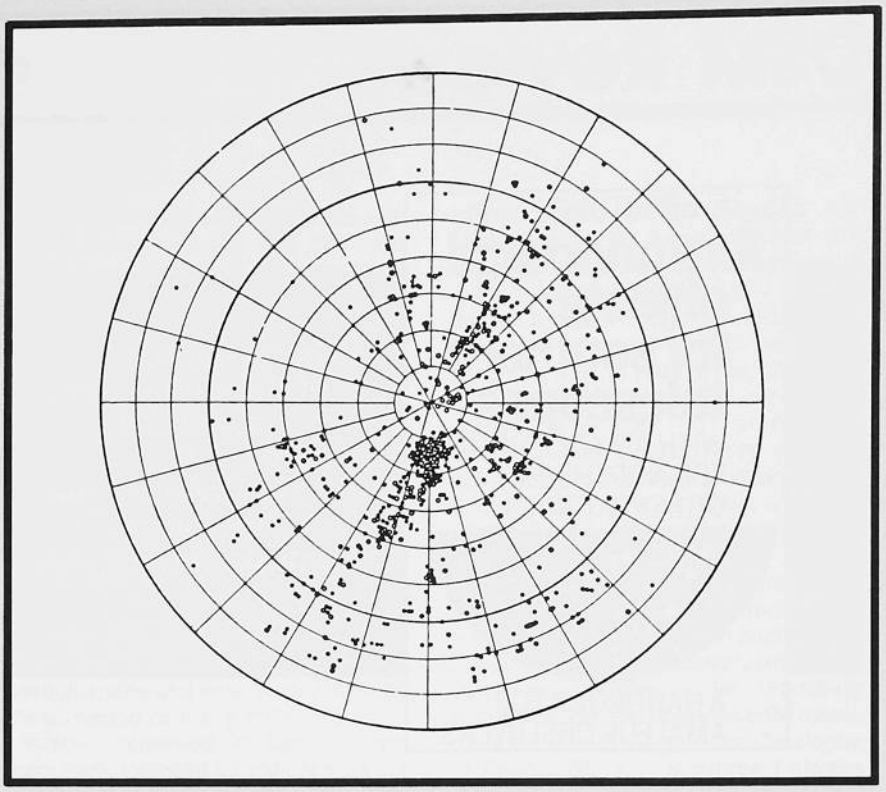
Harlow Shapley, in a chapter from *The Inner Metagalaxy* (Yale, 1957) titled "Deception," walks right past the supergalaxy. In plots of the Shapley-Ames catalogue, he admits to the Virgo "aggregation" in the north and the Fornax and other "groupings" in the south. Generally, however, Shapley dismisses the significance of large-scale structure: ". . . but taking the survey to fainter magnitudes erases much of the evidence of a basic metagalactic plane. These clusters and clouds of galaxies appear to be assemblages of only local significance. Too much has been read into the distribution of a few hundred galaxies while ignoring the distribution of the thousands just fainter."

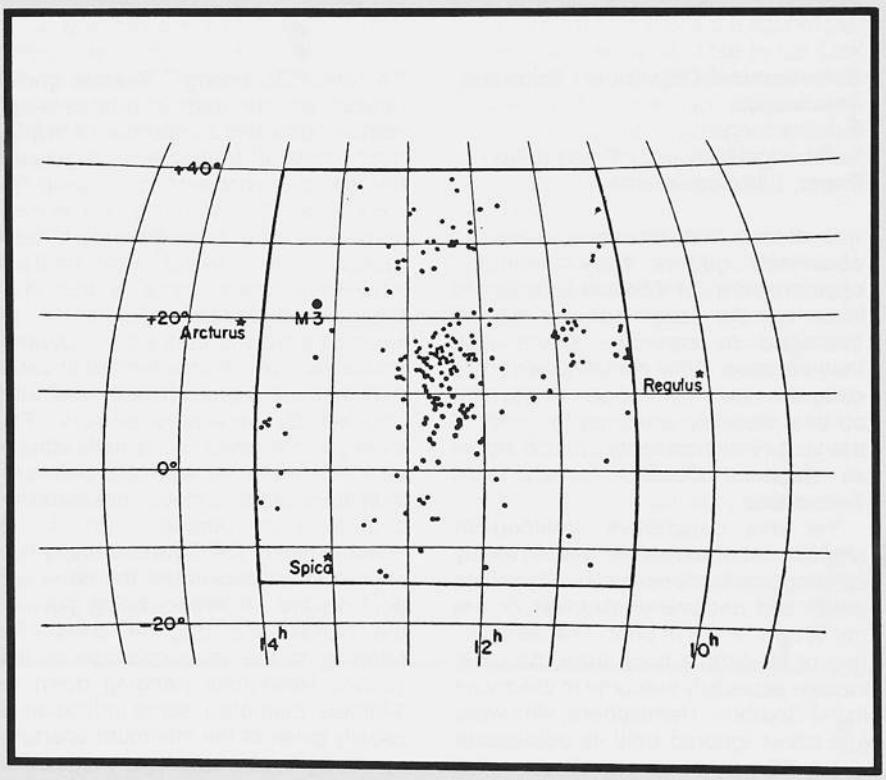
In *Galaxies* (Atheneum, 1961), Shapley warns of drawing conclusions based on the NGC and IC: ". . . a number of general conclusions have been correctly drawn from such plots, but the material has always been recognized as inhomogeneous. The Herschelian 'sweeps' in the original search for nebulous objects were more complete in some parts of the sky than in others. Here and there the later surveys, using photographic methods, had dipped deep into space and brought up for the catalogues many faint objects in a small area. As a result, the undiscriminating plots of the entries in the NGC and IC occasionally seem to indicate a clustering of galaxies, when the true interpretation is merely depth in the census at that place, or unusual thoroughness."

With 20-20 hindsight, of course, these arguments seem pretty soft. Given the context of their times, however, they generally make good sense. I will leave the job of identifying individual galaxies and clusters of galaxies on this chart up to you. It's no more difficult than star hopping if you use Tirion's *Sky Atlas 2000.0*. So have fun. We'll be back next issue with the galaxies of the Southern Hemisphere.



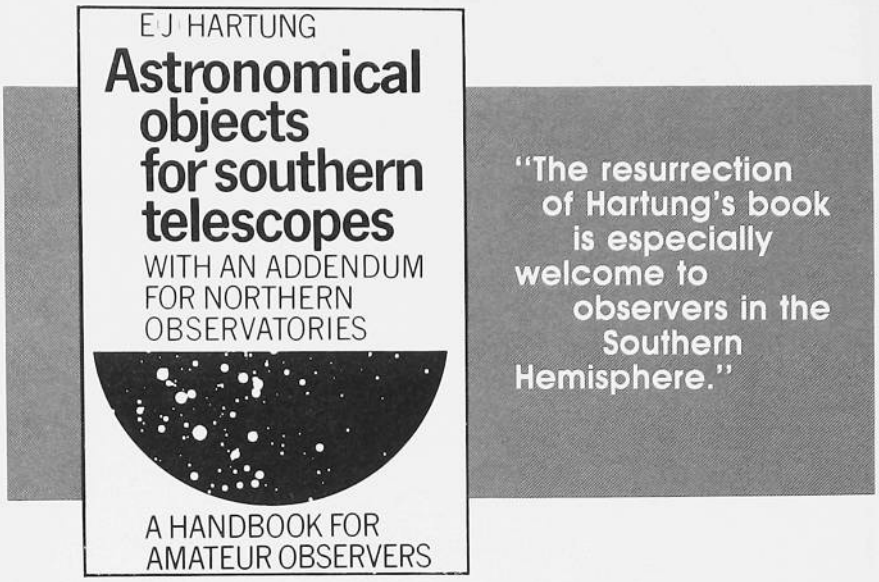






Opposite page: Richard Berry's northern sky plot of the RNGC galaxies is centered on the Virgo cluster (indicated by circle); its dots indicate galactic brightnesses. How many galaxies can you identify on this map? ***Top:*** An earlier plot from *Metagalaxy* shows the rough distribution of bright galaxies in the northern sky. ***Above:*** Galaxies in the Virgo cluster plotted within the "Arcturus-Spica-Regulus triangle." From Shapley's *Metagalaxy*.

DSM Reviews


E.J HARTUNG
Astronomical objects for southern telescopes
WITH AN ADDENDUM FOR NORTHERN OBSERVATORIES
A HANDBOOK FOR AMATEUR OBSERVERS
"The resurrection of Hartung's book is especially welcome to observers in the Southern Hemisphere."

Astronomical Objects for Southern Telescopes
E.J. Hartung
Cambridge University Press (1985)
Paper, 238 pages, $19

It seems that whenever deep-sky observers gather, they inevitably compare views of different objects and boast of the tough targets they've managed to convince themselves they've seen. The desire (need?!) to compare one's own observations with other's probably accounts for most of the long-term popularity of such works as *Celestial Objects for Common Telescopes*.

Yet this descriptive lifeblood of amateur astronomy is not well served by existing publications, which either lack detail and comprehensiveness or are out of date or out of print. The resurrection of Hartung's book from the latter class is especially welcome to observers in the Southern Hemisphere, who were just about ignored until its publication nearly 20 years ago.

The new edition is merely a reprinting of the original without any changes. While preserving a relatively unknown classic, the four introductory chapters describing the different classes of deep-sky objects are now woefully outdated. Cambridge would have done well to fix them up; readers should ignore these chapters.

However, new readers, particularly those just starting out in astronomy, should not pass over the chapter titled "Amateur Observing." Besides giving details of his instrumental set-up, Hartung provides a collection of helpful hints ranging from clever hardware fittings and preventing dew-up of eyepieces to keeping warm. In consideration of contemporary hi-tech gadgetry often found with amateur equipment today, some of this may seem, well, quaint. But some of Hartung's advice concerns accoutrements that have not diminished in value and that are being rediscovered and adopted by serious observers. For example, the uses of a simple direct-vision prism spectroscope are described, as is a clever prism-based double-star micrometer.

About half of the thousand-and-a-few objects described in the the book are double stars, preference being given to the closer and brighter pairs. By referring to the aperture stops on his 12-inch Newtonian (ranging down to 3-inches' diameter), some indication is usually given of the minimum aperture necessary to give satisfactory resolution of a pair, or a reasonably bright view of a galaxy or a cluster.

Hartung was particularly fond of globular clusters and planetary nebulae — not surprising, living as he did where the center of the Galaxy passes nearly overhead. Of the globulars, he described all he could find in his telescope. Clearly Hartung found galaxies boring. In his introductory remarks about the constellation Virgo, he complains that "there is a certain sameness in many of these spots of luminous haze . . . ."

The description of an object will sometimes say nothing about its telescopic appearance: Hartung is prone to distraction by historical backgrounds or features seen only on photographs. The majority of the descriptive blocks are usefully informative, or at least marginally so, but are rather plain reading although this book is not intended to be read straight through. Occasionally the descriptions are lucid and enticing, particularly for the far-southern spectacles. Regarding the central star of the η Carinae nebula, Hartung says: "The bright orange η Car is surrounded by an orange red nebula about 3″ wide, just visible with 10.5 cm, and the spectrum of the star shows numerous bands with the red Hα shining like a tiny lamp at one end; this too can just be seen with 10.5 cm." The efficacy of the visual spectroscope is well shown here — and with only 4 inches' aperture. Marvelous!

At least one early reviewer of this book complained about the separation of objects belonging to the Magellanic Clouds. Because they both spread into at least two constellations, Hartung isolated them under the archaic headings "Nubecula Major" and "Nubecula Minor." This is obviously the way to do it, and a clear convenience to observers who otherwise would have to fumble all the way through the book to find many objects in the Clouds.

Though constellations in the Southern Hemisphere are particularly well covered, Hartung includes regions up to about +30° declination, beyond which objects were very low on his northern horizon. An appendix gives a list of northern objects out of his reach, which includes brief descriptions based on other publications. Fortunately, they are not merely the usual, overly viewed objects: the selection may open the eyes of some northern observers. These objects were probably as enigmatic to Hartung as the southern sights are to the rest of us.

Because three-quarters of the sky is covered in the book, it is quite useful to amateur observers worldwide. Those living in the southern U.S., for instance, will find in it the only modern descriptions of objects at declinations accessible along their southern horizon — down there where Crux and Carina culminate just above the trees.

— Brian Skiff.

Double Stars

Take a Crack at Leo

By Glenn F. Chaple, Jr.

One of the first columns I wrote for this publication (then known as *Deep Sky Monthly*) described double stars found in the foresection of the celestial lion, Leo. In the seven years that have since elapsed I have, unintentionally, avoided the poor Lion like the plague. My omission is most unfortunate because Leo's hindsection contains some impressive stellar pairs for small and medium telescopes.

For example, **88 Leonis** (Σ1547) lies roughly midway between Beta (β) and Theta (θ) Leonis. Based on magnitudes (6.4 and 8.4) and separation (15.4″ in p.a. 328° [1958]) alone, you might expect this double star to be rather ordinary in appearance. But the night sky is full of surprises.

Observers using 4-inch or larger scopes will notice that 88 Leonis' component stars display marked color contrast. I won't mention what these colors are but will leave this for you to discover: view the pair with an open mind and, if you wish, report your impressions to me for a future column. This star is an easy mark for small telescopes — I've split it with a 3-inch reflector at 60x — but the colors aren't prominent in small scopes. Both the separation and position angle of 88 Leonis have increased slightly according to measures made two centuries ago.

Just less than halfway between β and Delta (δ) Leonis is the triple star **90 Leonis** (Σ1552). This system also fell prey to my trusty 3-inch reflector, with the main pair (magnitudes 6.0 and 7.3 and separation 3.3″ in p.a. 209° [1958]) just being resolved at 60x. These two stars have shown no definite orbital motion, but their common proper motion virtually assures the existence of a gravitational link between them. The third, outer star, on the other hand, appears to be only an optical companion. It shines at magnitude 8.7 and lies at a distance of 63.1″ in p.a. 234° (1958).

A mere optical connection also seems to be the case with the wide, unequal pair **81 Leonis** (h4433), which is situated about 2° west and slightly south of 90 Leo. The gap separating the magnitude 5.6 primary from its 9.2 magnitude partner is slowly narrowing. I suspect that the two are a few arcseconds closer than the Lick Catalogue's 1924 value of 55.7″ (p.a. 351°). If you're viewing 81 Leonis with a small-aperture scope and can't see the faint star, try moderately high power (75-100x) and averted vision.

About 6° north of β Leonis is the fourth-magnitude star **93 Leonis**. Like 81 Leonis, it is a wide and unequally bright double star. In *Deep Sky* 13, we looked at Struve's supplementary catalogue into which he logged prominent pairs whose separations exceeded 32″. 93 Leonis fits this category; it bears the Struve designation ΣII 7. The companion is 100 times (five full magnitudes) fainter than the primary and is located some 74.3″ to its north. Another optical partnership? Apparently not. The two are traveling together through space and must surely have an orbital period of many millennia.

When I observed 93 Leonis some years back, I noticed a similarly wide but fainter pair in the same field. The Lick Catalogue identifies this duo as **Shj 130** — a pair discovered by the English astronomers John Herschel and James South during the early 1820s. The statistics on Shj 130 read like those of 93 Leonis except for the magnitude of the primary, which for Shj 130 is about 8.3. Is Shj 130 an optical system or a true binary system? A slow but steady decrease in their separation indicates the former.

If you point your telescope a bit west of the midpoint between 90 and 93 Leonis, you should be able to pick up the double star **Σ1565**. This is another pair that small-scope owners can cash in on. The magnitude 7.0 and 8.9 components are a spacious 21.6″ apart in p.a. 304° (1955). Use 40x to 60x for a clean split on this common proper motion system.

If your telescope is at least 4-inches in aperture and has excellent optical quality, you may want to check out the binary system **Σ1527**, located 1.5° southeast of (θ) Leonis. When discovered and measured by Struve in 1829, these magnitude 7.0 and 8.1 stars were 3.9″ apart in p.a. 10°. Since then they have slowly drawn together, reaching 3.3″ in p.a. 19° by 1912 and 1.7″ in p.a. 28° by 1967. Their present separation of just 1.3″ in p.a. 35° demands high magnification (at least 150x) and good seeing conditions. Don't bother with Σ1527 on nights when the stars twinkle wildly and their telescopes images "boil."

We'll wind down our observations with one last double star, which poses a minor problem: I have no background info on the pair's discoverer. I stumbled upon this double while thumbing through the pages of my favorite novel, the Lick Observatory *Index Catalogue of Double Stars* — a source I always refer to when seeking obscure, off-the-wall double stars to include in these pages. This time my find is a double star called **Kustner 38**. A table in the Lick Catalogue credits the discovery to F. Kustner and further data indicate that Ku 38 was one of several dozen pairs he (or she — the "F" could stand for Francine) discovered around the turn of the century.

Being a very diligent double star reporter, I poured through all the books in my home astronomy library, trying to find out who the heck F. Kustner was. I found nothing. Oh well, does it really matter? Ku 38 lies a degree northwest of 86 Leonis and consists of twin 10th-magnitude stars that are separated by 6″. Hey! I bet "F" stands for Friederich. Kustner has a German ring to it. (Excuse me, I'm digressing; after all, it really doesn't matter.)

One thing is for sure: if you glimpse Ku 38, you'll be one of just a handful of people who have ever seen it. I mean,

Star	R.A.(2000)Dec.	Mags.	Sep.	P.A.	Year
88 Leonis (Σ1547)	11h31.7m +14°22′	6.4, 8.4	15.4″	328°	1958
90 Leonis (Σ1552)	11h34.7m +16°48′	6.0, 7.3	3.3″	209°	1958
81 Leonis (h4433)	11h25.6m +16°27′	5.6, 9.2	55.7″	351°	1924
93 Leonis (Σ117)	11h48.0m +20°13′	8.4, 9.1	2.9″	254°	1936
Σ1565	11h39.6m +19°00′	7.0, 8.9	21.6″	304°	1955
Σ1527	11h19.0m +14°16′	7.0, 8.1	1.3″	35°	1967

when was the last time you saw a photo of Ku 38 on the pages of *Astronomy* or *Deep Sky* magazine? Did you ever see it described in Walter Scott Houston's "Deep Sky Wonders" column? Yes-siree, the select group of Ku 38 observers will include only you, a handful of die-hard double star fanatics, and good old (young?) F. Kustner.

* * *

Double Takes . . . All right, I'll admit that I'm dying to know who F. Kustner is. Can you help me? If you live near a big city or large university library, check through the resources and see what you can come up with. I'll do the same next time I make the trek into Cambridge, Massachusetts. Let's bring this dedicated double star observer out of obscurity!

A year ago, I mentioned an awards program that the Saguaro Astronomy Club of Phoenix, Arizona had set up for any member who notches all of the "Top 100" double stars I featured in this column back in 1983. Not long ago, I received a packet from club member A.J. Crayon who had performed the feat using an 8-inch f/6 Newtonian. Congratulations to Mr. Crayon and thanks to all of you for a batch of very useful notes.

I'd also like to acknowledge the fine efforts of two regular readers of this column. John Bartels of Fairfield, California and Gus Johnson of Swanton, Maryland have regularly contributed notes on double stars that they have encountered during their observing sessions. Their notes, along with Mr. Crayon's and those of other *DSM* readers, are placed in my files for future use.

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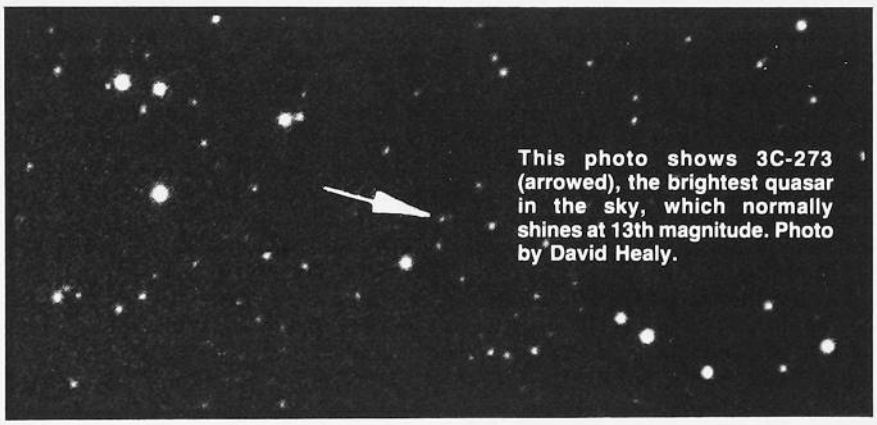
Variable Stars



This photo shows 3C-273 (arrowed), the brightest quasar in the sky, which normally shines at 13th magnitude. Photo by David Healy.

A Collection of Fine Spring Stars

by David H. Levy

Spring! When the variable stars seem to keep a sort of undefined cosmic watch over the rebirth of fortunes for our little planet. Spring can also be a bad time, with final exams and other pressures bothering those of us who teach and learn. Little wonder T.S. Eliot began his greatest poem *The Wasteland* with: "April is the cruelest month . . . ." He was probably getting ready to observe variables after reading about how wonderful spring was, and then a storm came and it stayed cloudy for three weeks.

Actually, this particular spring is especially good for variables. With practically everyone observing a certain nonstellar fuzzy thing that happens to be undergoing its 76-year visit, there are relatively few people observing variables; so take out your telescope — the lines are shorter!

This time around we'll look at all kinds of variables that are spaced liberally around the sky. From bright stars such a Y Lyncis to fascinating dwarf novae like Z Camelopardalis, from a bright group of stars in Ursa Minor to a faint quasi-stellar object in Virgo, spring is the time to watch the cosmic dance at its best. Come on, let's party!

072046 **Y Lyncis**. With a half-magnitude range of 7.2 to 7.8, Y Lyncis is one of those semi-regular variable stars for which visual observing is problematical because of its low amplitude. Estimate this star's magnitude once a month under a moonless sky, using the same equipment each time — and watch out for the Perkinje effect. (Remember: As with any star, the more you keep observing conditions constant, the more accurate and consistent your estimates will be.)

081112 **R Cancri**. About 10° southwest of the Beehive Cluster (M44) lies the bright Mira-type variable R Cancri, which has a period of about a year (360 days) and a range of over four magnitudes. Its maximum magnitude of 6.8 is bright enough to make it visible through binoculars and its minimum of 11.2 is still bright enough to see using a small telescope. To find R Cnc, go about 2.5° north of the 4th-magnitude star Beta (β) Cancri.

085120 **T Cancri**. This star is a magnitude 7.6 to 10.5 semi-regular variable with a period of 482 days.

084917 **X Cancri**. One of the spring sky's best, bright variables, this star is located southeast of M44. Its magnitude range of 5.9 to 7.3 keeps it within binocular range at any time, but X Canc's period of 165 days is slow and calls for observing but only once a month.

043065 **T Camelopardalis**. This is a reddish Mira star that ranges almost six magnitudes, varying from 8 to 13.8. It is easily found by moving almost 1.5° west of the 4.4 magnitude star Alpha (α) Camelopardalis. As T Cam rises from minimum you may notice two things: about a magnitude before its peak, the star may simply stop rising for a while (a standstill) or even drop a bit in brightness (a hump). You might also note a leisurely stay near maximum, typical of the ulta-red spectral class "S" stars.

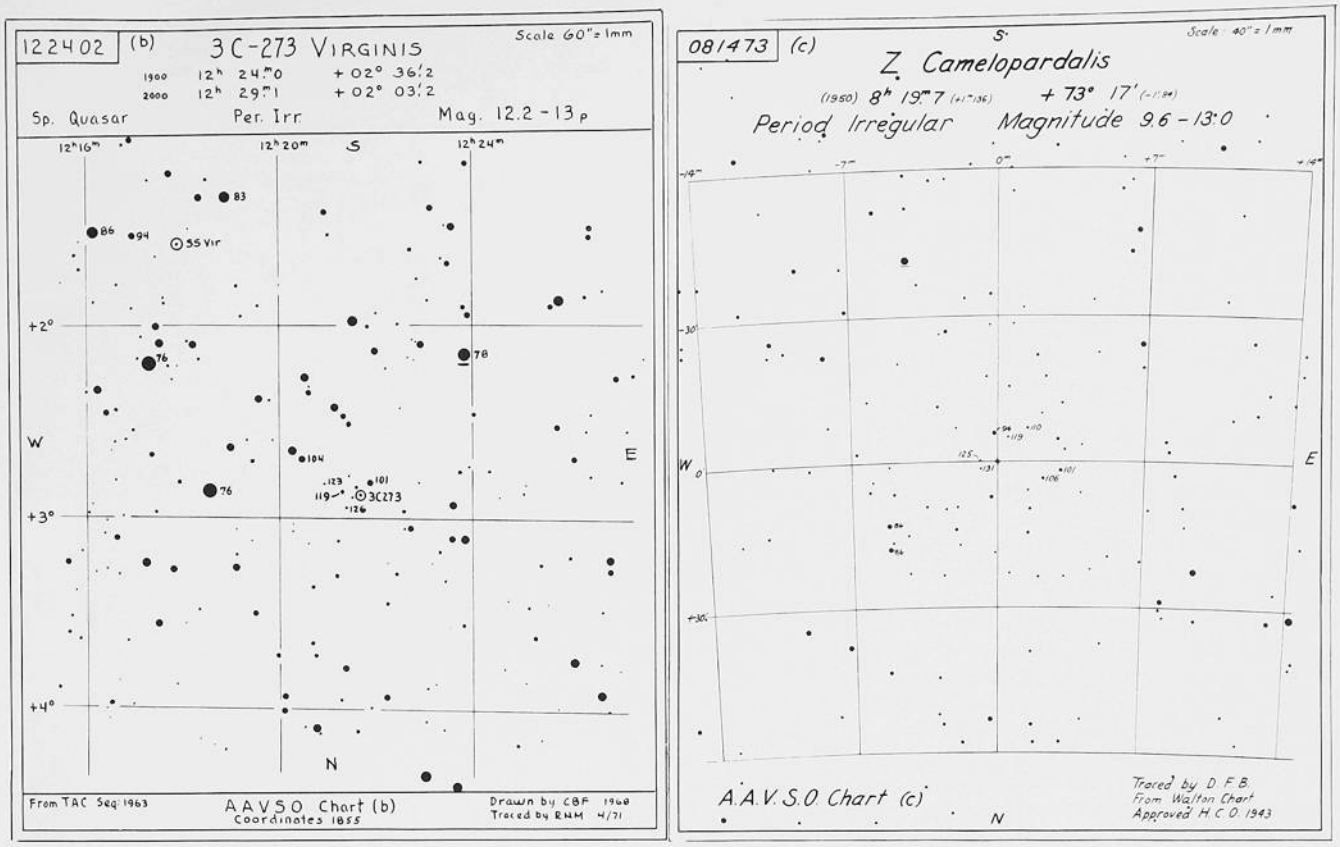
043274 **X Camelopardalis**. This Mira-type star's magnitude range is 8.1 to 12.6 and its period of 143 days is short enough to detect change every week. This star enables you to study the behavior of Miras in accelerated time, with 2½ light curves during a single year.

If we could monitor a variable star year-round without any seasonal interruptions, we would really be able to evaluate a star's behavior and know it well. What's more, if our hypothetical variable varied fast enough and over a wide enough range, say five magnitudes over five months, then we'd have a star that presents exciting changes every week. In **X Camelopardalis**, we have just such a star.

081473 **Z Camelopardalis** is a star whose exploding fluctuations are often interrupted by standstills. Occasionally this dwarf nova "decides," on its way down from a maximum, that it is tired of playing nova and just sits for a period of weeks, months, or even (as in the late 1970s) years.

163172 **R Ursae Minoris**. Ranging in magnitude from 7.8 to 11.7, this semi-regular variable has a period of 324 days.

153378 **S Ursae Minoris**. Because this star is so close to the north celestial pole and is visible year-round from most northern observing sites, it is one of the most captivating Mira stars. S UMi's period is 322 days, or about 11 months. Its magnitude range of 8.3 to 11.5 offers easy observing with even a



These finder charts show the fields surrounding the quasar 3C-273 in Virgo and the unusual dwarf nova Z Camelopardalis. To observe them zero in on the field and check the stars whose magnitudes are given on the chart to estimate the object's brightnesses. Charts used by special permission of Janet A. Mattei, director, American Association of Variable Star Observers.

3-inch telescope. S UMi is just over a degree north of 5.3 magnitude Theta (θ) Ursae Minoris, one of the stars in the Little Dipper's bowl.

Although R and S UMi are best viewed in spring, they are quite close to the pole and hence can be followed year-long for most Northern Hemisphere observers. Use a 3-inch telescope to observe these stars. Theta and Xi (ξ) Ursae Minoris are excellent guide stars for finding S UMi.

122402 **3C 273** Virginis. As the brightest known quasar, 3C 273 Virginis appears as a starlike object of about 13th magnitude. A quasar (short for quasi-stellar object) is not a variable star but rather the highly-energetic core of a distant galaxy. If the galaxy were "normal," like M31 or the Milky Way, we would expect to see nothing because of its great distance. But the central part is visible so it appears starlike in our telescopes.

Observationally, quasars are much like variable stars in that their variations are slow and highly irregular but manifest themselves in the quasar's changing brightness.

I first saw 3C 273 Virginis with a 6-inch reflecting telescope, locating it just as I would find an ordinary variable. When I began to make the estimate (as I would estimate an ordinary variable), I realized that this little point of light may be the most distant object I had ever seen — the core of a galaxy some 920 megaparsecs away. With a sobered and respectful feeling, I continued observing. Estimate this quasar's brightness once a month. Its variation is slight, but it's fun to look at an object that far away — so enjoy!

104620 **V Hydrae**. I met V Hydrae surreptitiously one morning while searching for comets. Field after field went by, and then there appeared one of the reddest stars I have ever seen. This is a star you do not have to work with to appreciate; just looking at its field is a thrill. According to the *General Catalogue of Variable Stars*, the mean magnitude changes by about five magnitudes over 18 years so that deep minima were seen in 1891, 1909, 1926, 1942-43, and 1959-62. Superimposed on this longer period is a shorter range of 1.5 to 4 magnitudes.

142539 **V Bootis**. This star normally changes between magnitudes 7 and 11.3 in a period of 258 days, but in the early 1970s it simply stopped varying for several months — only to continue its normal variation afterward. V Bootis is a bright variable, easily found, and quite interesting! Here is a star of spring whose bright minimum means that you can follow its whole period with a 2.4-inch reflector.

145508 **Delta** (δ) **Librae**. A bright eclipser that is similar to Algol, this star fades by about a magnitude every 2.327 days. Its maximum magnitude of 4.8 is easily visible through binoculars or with unaided eyes from a dark country site, and the same is true for its 5.9 minimum.

AAVSO#	Name	Period	Type	Range
072046	Y Lyncis	110d	Semi-regular	7.8–10.3
081112	R Cancri	362d	Mira	6.1–11.8
085120	T Cancri	482d	Semi-regular	7.6–10.5
084917	X Cancri	195d:	Semi-regular	5.6–7.5
043065	T Camelopardalis	373d	Mira	7.3–14.4
043274	X Camelopardalis	144d	Mira	7.4–14.2
163172	R Ursae Minoris	324d	Semi-regular	8.8–11.0
153378	S Ursae Minoris	326d	Mira	7.7–12.9
142539	V Bootis	258d	Semi-regular	7.0–12.0
145508	Delta (δ) Librae	2.3d	Eclipsing	4.9–5.9

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Scanning the Literature

May - September 1985

by Brian Skiff

The September 1985 issue of *Astronomical Journal* (*AJ*) contains a magnum opus on the Virgo cluster of galaxies by Bruno Binggeli, Allan Sandage, and Gustav A. Tammann. Titled "Studies of the Virgo Cluster. II. A Catalog of 2096 Galaxies in the Virgo Cluster Area" (*AJ* **90:**1681), this 80-page paper gives a detailed assay of galaxies found in an area measuring about 140 square degrees that is centered on the Virgo cluster. The authors attempt to list all known and possible cluster members brighter than integrated B magnitude 18, intrinsically faint dwarf galaxies to about magnitude 20, and all objects listed in the "Zwicky catalogue" (*Catalog of Galaxies and Clusters of Galaxies*) — be they cluster members or background objects. Tables list precise coordinates, total magnitudes, dimensions, morphological types, and velocities.

Parts I through V of this series of six papers are now published, and are preparatory work toward study of the Virgo cluster by the Hubble Space Telescope. The current study provides a groundwork of basic information on a uniform system, enabling a selection of interesting objects to be examined in detail.

A brief article with a long title — "Spectra of the Two Brightest Objects in the Amorphous Galaxy NGC 1569: Superluminous Young Star Clusters — Or Stars in a Nearby Galaxy?" (*AJ* **90:**1163, July) — is interesting if only because its authors, Halton C. Arp and Allan Sandage, have in the past been adversaries in the ongoing galaxy distance/redshift controversy. In this paper, they analyze spectra of two bright stellar objects in a relatively nearby galaxy whose distance is nevertheless (and appropriately for these authors) uncertain by as much as a factor of 10. Such small, bright features in irregular galaxies are usually giant HII regions (see below), but the present work suggests other things are going on in NGC 1569.

What is certain from the available observations is that the two starlike condensations are members of NGC 1569 since their radial velocities match that of the entire galaxy. The spectra indicate that they seem to be dominated by a stellar component similar to early-A supergiant stars like Deneb, but a

National Optical Astronomy Observatories

The giant elliptical galaxy M87 in Virgo with its halo of globular clusters: ***Binggelli, Sandage, and Tammann continue their authoritative series of papers on fundamental data for the Virgo cluster.***

The sprawling nebula NGC 2070 inside the Large Magellanic Cloud: *Astronomers are asking, "What sorts of powerful beasts lie hidden deep within the cores of a nebula like NGC 2070?"*

strong ultraviolet continuum present in the spectra indicates that a hotter component also exists in the condensations.

The astronomers offer two alternatives to explain these observations. If the galaxy's distance is about six megaparsecs, the objects could be young star clusters — the most luminous yet found. Other, weaker arguments suggest a distance of only 400 kiloparsecs; in this case, the features could be peculiar and very luminous individual stars. The authors note that resolution of the objects into stars (single or multiple) by the Space Telescope would be decisive.

Not to be outdone, J. Melnick, M. Miles, and R. Terlevich claim to have found a cluster even more luminous in the southern galaxy NGC 1705, which they report on in their paper "The Super Star Cluster in NGC 1705" (*Astronomy & Astrophysics* **149:**L24, August II). Based on spectroscopic observations similar to those in the Arp-Sandage paper, the authors found a mean spectral type of B3 V for the 14th-magnitude feature in the galaxy. Using an assumed distance of 8.7 megaparsecs, the absolute magnitude of the proposed supercluster is $M_B = -15.4$, or more than two magnitudes brighter than the objects in NGC 1569.

Incidentally, the condensations in galaxies NGC 1569 and NGC 1705 are bright enough to discern as stellar points within their parent galaxies using telescopes that are 12.5 inches and larger.

These objects may represent new types of star cluster complexes that illuminate giant HII regions. The best studied of such phenomena include NGC 2070 (also called 30 Doradus or the Tarantula Nebula) in the Large Magellanic Cloud and NGC 3603 in the Milky Way, located in the constellation Carina. Two recent publications that have shed new light on these objects are "Probing the Luminous Stellar Cores of the Giant HII Regions 30 Dor in the LMC and NGC 3603 in the Galaxy" by Anthony F.J. Moffat, Wilhelm Seggewiss, and Michael M. Shara (*Astrophysical Journal* (*ApJ*) **295:**109, 1 August) and "R136a and the Central Object in the Giant HII Region NGC 3603 Resolved by Holographic Speckle Interferometry" by G. Weigelt, G. Baier, and R. Ladebeck (European Southern Observatory *Messenger*, Number 40, June 1985; *Astr. & Astrophys.* **150:**L18, September I).

It has been variously suggested that these objects are either single supermassive stars of a size that strains current physical laws or remarkably tight groups of the hottest and most normally massive stars observed elsewhere.

The Moffat group imaged the objects on a CCD with a set of narrow- and broad-band filters that distinguish massive Wolf-Rayet stars from normal hot O-type stars by their characteristically peculiar emission lines. The group also made spectroscopic observations of individual stars in the field. The CCD images indicate that the central object in 30 Doradus, called R136a, is an agglomeration of Wolf-Rayet and O

NGC 3603 in Carina photographed with the 4-meter Mayall telescope on Kitt Peak: *a core some 1/10 the size of NGC 2070's but only a single magnitude fainter.*

stars, the sum of which is not much brighter than nearby single stars and does not dominate the light output of the surrounding nebula. R136a is known to contain at least two stars based on observations made by visual double star observers. The Moffat group, therefore, proposes that "there is no need to postulate a single star of extraordinarily high luminosity (or mass)."

Among several other results, the astronomers found that the core of NGC 3603 is only one-tenth the size of 30 Doradus but is only about a magnitude fainter overall, implying that NGC 3603 is possibly 300 times denser than 30 Doradus.

The Weigelt group obtained 8,000 speckle interferograms of R136a. Their reconstruction shows that the object consists of at least eight stars. Three of these are nearly identical in brightness and comprise the half-arcsecond double star measured by visual observers (the two form a 0.1″ binary). The compact core of NGC 3603, observed in the same way, shows four components.

These excellent results, acquired through a combination of spectroscopy and speckle imaging, seem to close the first chapter on the nature of these objects in terms of the number of stars involved and the physical conditions of their surroundings. Of course, we still don't know how luminous O stars and Wolf-Rayets are related, or if the former become the latter in the course of their evolution, or even how the whole mess got going in the first place.

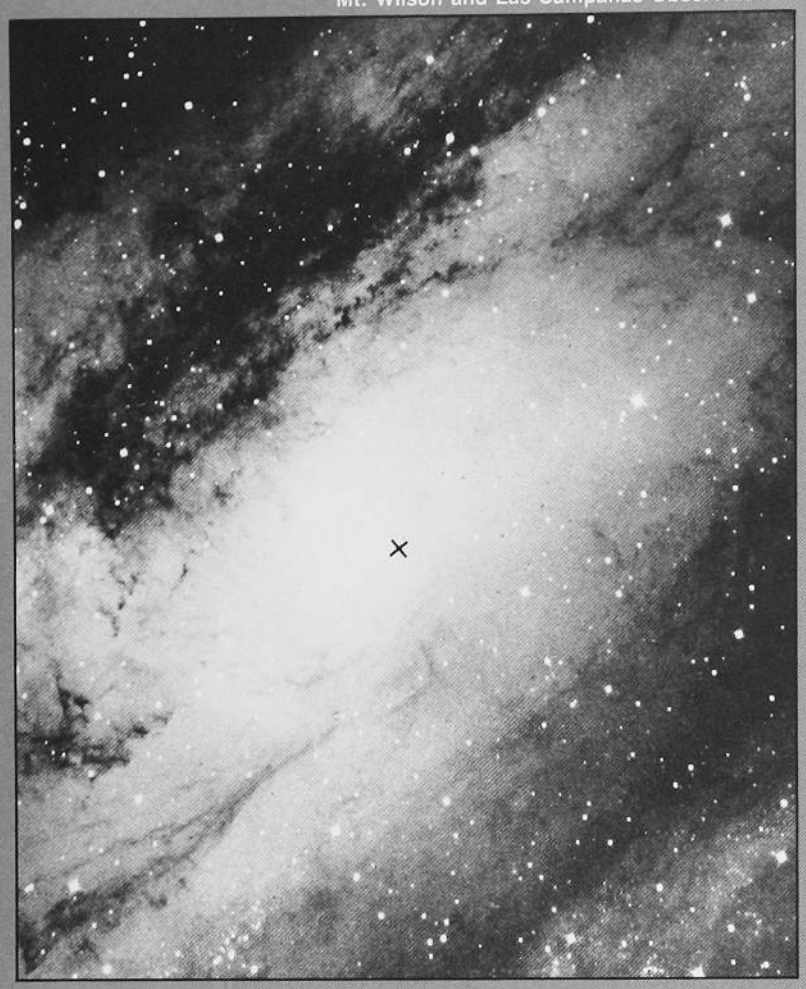
A new and very thorough historical analysis of the first recorded extragalactic supernova is presented by Gerard de Vaucouleurs and Harold G. Corwin, Jr. in "S Andromadae 1885: A Centennial Review" (*ApJ* **295:**287, 15 August). The star erupted in late August 100 years ago near the center of the Andromeda Galaxy, resulting in a flurry of activity among astronomers of the day. The authors present an exhaustive discussion of these early observations, including "prediscovery" sightings, positional and brightness measures, and even examination by observers using visual spectroscopes.

A definitive light curve for the supernova was compiled by adjusting the visual estimates of many observers — most of whom used the then-new BD charts as a source of comparison stars — to the standard photoelectric V scale. The authors estimate that the supernova reached a peak brightness of V = 5.85 on August 21-22, 1885. The star faded quickly to V = 10 by the end of September and to 14th magnitude by the end of January 1886.

One useful by-product of this work for amateur observers is a listing that provides new photoelectric V magnitudes and colors for over 40 stars in and around Messier 31. Precise R.A. and Dec. coordinates are listed and the stars are identified on a chart showing the region.

David G. Turner and Mario Pedreros present new information for two open clusters in eastern Sagittarius in "A Photometric Investigation of Cluster Membership for the Cepheid BB Sagittarii" (*AJ* **90:**1231, July). Photo-

Mt. Wilson and Las Campanas Observatories



The nuclear region of M31 showing the approximate position of S Andromedae (X), the great supernova of 1885: *de Vaucouleurs and Corwin provide a historical detective story complete with contemporary data.*

electric photometry and star counts for the close pair of clusters Collinder 394 and NGC 6716 are analyzed to determine whether the 7th-magnitude Cepheid variable is a member of either cluster. (Owners of *Sky Catalogue 2000.0*, volume 2, may wish to pull out their updating-and-correcting pencils at this point.) Both clusters are about 650 parsecs away and their projected separation on the sky is only seven parsecs — a true double cluster! Cr 394 has a core diameter of 18′ while its "tidal" diameter (beyond which stars are not gravitationally bound to the cluster) is 54′, or 10 parsecs. BB Sgr, located about three parsecs from Cr 394's center, is a probable member. The core diameter of NGC 6716 is 14′. For Cr 394, I summed the magnitudes of 51 stars in the cluster's region (specifically all stars measured in the core plus all members and probable members within the tidal "halo") to derive an integrated magnitude of V = 5.6. The brightest star, BB Sgr, was included at its mean V magnitude of 6.97.

New B and V magnitudes for the central stars of 51 planetary nebulae have been published by Richard A. Shaw and James B. Kaler in "Apparent Magnitudes of Luminous Planetary Nebula Nuclei. I. Method and Application" (*ApJ* **295:**537, 15 August). The new results are based on photoelectric observations in the Hα emission line and in two continuum bands that permit subtraction of the nebular emission from the total flux, which allows an estimate to be made of the contribution by the nebular continuum. The residual light of the central star alone is then converted to standard B and V magnitudes.

The comparison with previously published magnitudes is quite interesting: generally the new magnitudes are too bright due to inadequate compensation (sometimes none!) for the nebular continuum. Shaw and Kaler's new method is still uncertain because this contamination is not easy to measure, being a complicated function of the shape, age, temperature, surface brightness, and other physical parameters of the nebulae. Below magnitude 14.3, the authors find their own data may be giving magnitudes that are too bright.

Photographic magnitudes from 50 or more years ago are also found to be systematically too bright by an average of 0.75 (after correction, they are good to ±0.75 magnitude).

While we visual observers ferret out central stars, Kaler and his colleagues will be using this data to study the evolution of planetary nuclei and the physical conditions in the surrounding nebulae.

Double star observers have several new data sources to add to their files pertaining to measures of stars and their colors. "Micrometer Observations of Double Stars and New Pairs. XII" by Wulf D. Heintz (*ApJ Supplements* **58:**439, July) gives recent measurements for 2,235 pairs of stars, 103 of which are newly discovered. These are the latest results in a continuing program by the author to monitor close "motion" pairs and neglected faint pairs, and to examine stars brighter than magnitude 10 for duplicity. Most of the pairs listed are less than one arcsecond apart, and magnitude estimates that were not previously available are given for many fainter stars.

Spectral classification of the components of double stars is a useful tool for establishing the ages, evolutionary stages, luminosities, and masses of stars when combined with orbital data. Also, since doubles and multiples are more common than star clusters (where ages, distances, etc. are more reliably determined), peculiar stars too rare to be found in clusters can be studied among the doubles. For the visual observer, spectral types help assign colors to the components objectively.

In "Spectral Types of Components to Variable Visual Double Stars" (*Publications of the Astronomical Society of the Pacific* (*PASP*) **97:**434, May), Elaine M. Halbadel provides classifications for 45 companions to 42 variable stars that are members of double systems. Many of the companions are late spectral types (orange or reddish) and in several cases the spectra suggest that the companions are "optical" (chance alignments with the variable stars).

Helmut A. Abt of Kitt Peak (excuse me: NOAO) is engaged in a project to determine spectral types for all ADS pairs brighter than B = 8.0. His latest installment of this survey, "Visual Multiples. VIII. 1000 MK Types" (*ApJ Supplements* **59:**85, September), provides a fantastic new source of information for observers.

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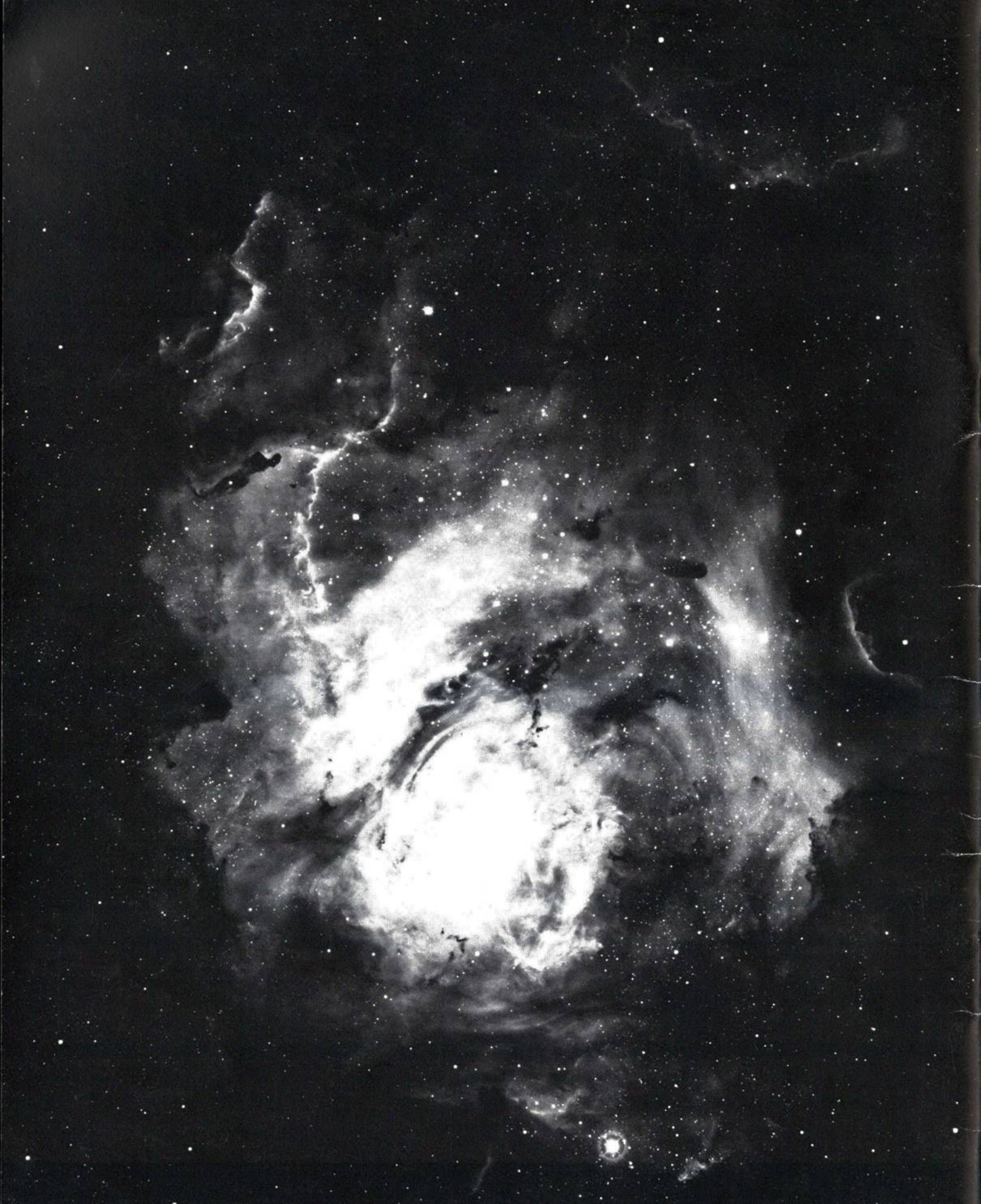

The Lagoon Nebula in Sagittarius

Kitt Peak National Observatory photo